WORLD'S POULTRY SCIENCE JOURNAL

APRIL - JUNE

1952

Official Organ of the

WORLD'S POULTRY SCIENCE ASSOCIATION

Volume 8 - Number 2

Poultrymen Need Not Risk Large Losses

SULFAQUINOXALINE

Proved superior for <u>both</u> prevention and control of coccidiosis outbreaks

SQ has reduced mortality to 2 per cent or less, even in multiple infections. It is the drug that:

- Stops all of the most damaging species of chicken and turkey coccidia.
- Is effective for both *prevention* and *control.*
- Prevents stunting and loss of finish when due to coccidiosis.
- Has no adverse effect on fertility, hatchability, or egg production.
- Protects even under warm, moist conditions.
- Permits birds to develop immunity to coccidiosis.
- Reduces immediate mortality resulting from acute fowl cholera.
- Performs consistently! With Sulfaquinoxaline, coccidiosis has ceased to be a problem in more than 160 successive flocks raised on the same farm over a period of five years.

Feed and remedy manufacturers supply Sulfaquinoxaline in feed mixtures or premixes, solution, tablets, or soluble powders.

Research and Production for Better Poultry and Animal Nutrition

MERCK

MERCK & CO., INC.
Manufacturing Chemists
RAHWAY, NEW JERSEY
In Canada: MERCK & CO. Limited — Montreal

© Merck & Co., Inc.

WORLD'S POULTRY SCIENCE JOURNAL

Volume 8 April-June Number 2

Editor

GUSTAVE F. HEUSER

Publication Committee

W. A. MAW, *Chairman*, Canada
C. F. ANDERSON, Australia
V. S. ASMUNDSON, U.S.A.
E. ENGLER, Switzerland
DR. FANGAUF, Germany
F. M. FRONDA, Philippine Is.
A. M. GERICKE, South Africa
E. T. HALNAN, England
N. ISLAM, Pakistan
LAURA KAUFMAN, Poland
J. W. KINGHORNE, U.S.A.
F. LIEVENS, BELGIUM
N. OLSSON, Sweden
C. L. MORGAN, U.S.A.
H. N. RAO, India
W. C. THOMPSON, U.S.A.
C. W. UPP, U.S.A.
D. URI, Palestine

Advertising Committee

O. B. KENT, *Chairman*, U.S.A.
W. P. BLOUNT, *Vice-Chairman*, England
F. BRAY, Canada
N. C. DeRYCKE, Belgium
H. EBBELL, Switzerland
A. D. GOLDHAFT, U.S.A.
R. T. PARKHURST, U.S.A.
L. PASSEBON, France
A. G. PHILIPS, U.S.A.

Published quarterly by the

WORLD'S POULTRY SCIENCE ASSOCIATION

Cornell University, Ithaca, N. Y., U.S.A.

Membership dues $3.00 a year of which $2.50 is for a year's subscription to the "World's Poultry Science Journal." Subscription rate, $3.50 a year. Advertising rates upon application.

Entered as second class matter May 31, 1945 at the Post Office at Ithaca, N. Y., under the act of March 3, 1879.

OFFICERS OF THE WORLD'S POULTRY SCIENCE ASSOCIATION

President, Mr. Alex Wiltzer (France)

Honorary Past Presidents

Professor A. Ghigi (Italy)
Professor J. E. Rice (U.S.A.)
Mr. W. A. Kock (Denmark)
Mr. W. D. Termohlen (U.S.A.)

Vice Presidents

Dr. R. Coles (England)
Mr. J. W. Kinghorne (U.S.A.)
Mr. C. S. Th. Van Gink, (Holland)
Mr. H. Engler (Switzerland)
Dr. F. Lievens (Belgium)

Treasurer and Assistant-Secretary

Dr. G. F. Heuser (United States of America)

Secretary and Assistant-Treasurer

Major Ian Macdougall (England)

Members of Council:

Australia: Mr. R. W. Kurrle
Belgium: Mr. J. Van Ingelgem and Professor P. Willems
Canada: Professor J. R. Cavers and Mr. G. L. Landon
Denmark: Professor D. Adsersen and Mr. J. Traberg.
Eire: Mr. D. Philpott
England: Mr. D. J. G. Black, Dr. R. F. Gordon, Mr. E. T. Halnan, Mr. C. Horton-Smith, Dr. S. K. Kon, Mr. W. Marshall, and Mr. K. Wilson.
Finland: Professor N. Westermarck
France: Mr. P. Waroquiez
Germany: Dr. A. von Burgsdorff-Garath and Dr. H. Havermann
Holland: Professor L. de Blieck and Mr. J. G. Tukker
India: Mr. S. G. Iyer
Israel: Mr. A. Livshutz
Italy: Professor Anita Vecchi
New Zealand: Mr. J. G. Kissling
Northern Ireland: Dr. J. G. Rhynehart
Norway: Mr. L. Svendsen
Pakistan: Mr. Nurul Islam
Scotland: Miss M. M. MacLeod and Mr. J. E. Wilson
South Africa: Professor A. M. Gericke
Spain: Mr. Luis Latorre
Sweden: Mr. E. Haeggblom and Professor N. Olsson
Switzerland: Mr. H. Ebbell and Mr. H. Kleb
U.S.A.: Mr. H. H. Alp, Dr. C. D. Carpenter, Dr. E. M. Funk, Mr. R. R. Hannas, Mr. R. M. Hanson, Dr. R. J. G. Jaap, Dr. M. A. Jull, Dr. O. B. Kent, Mr. M. C. Small and Mr. J. D. Sykes.

CONTENTS

World Egg Production in 1951 : Current Chicken Numbers 84

Sweet Potato Root Meal versus Yellow Corn Meal in the Chick's Diet
M. M. Rosenberg and J. Seu 93

Newcastle Disease
E. C. Lloyd 99

Newcastle Disease
N. Dobson 107

New Theories on Methods of Selection and Mating in Poultry
R. G. Jaap 114

Pullet Rearing and Egg Production on Home Grown Foods
R. B. Shaw and E. W. Nightall 128

Control of Lice and Mites
F. E. Allen 132

Surface Active Agents as Growth Stimulators in Chick Rations
C. M. Ely and Stuart Schott 133

Recent Findings in Poultry Nutrition
G. F. Combs 144

Review of Poultry Publications 147

WORLD EGG PRODUCTION IN 1951: CURRENT CHICKEN NUMBERS*

In 1951 world egg production failed to show a significant increase for the first time since 1946, according to the Office of Foreign Agricultural Relations. Egg production and chicken numbers were lower or previous uptrends were halted in most important producing countries in 1951 as compared with a year earlier. In general, the cut back in poultry production for meat has not been as great as the decline in egg output.

The reversal in trend of egg production experienced since 1946 is especially marked in Western Europe. By 1951 production of eggs and poultry had generally reached or exceeded prewar levels and the increased supply of eggs and poultry together with higher feed costs resulted in less favorable returns to producers. Notable exceptions to the slackening in egg and poultry output occurred in Western Germany, Austria, Italy and the Philippines where the postwar build-up came slower than in other countries. While the uptrend in chicken numbers halted in the Netherlands, egg production continued upward because of a higher rate-of-lay per bird.

The most significant downward changes in egg production occurred in those countries exporting eggs. Unsatisfactory export prices of eggs in relation to feed prices and other costs were undoubtedly a major factor in reduced output. Chiefly affected were Belgium, the Scandinavian countries and Ireland. Canadian output, which had been cut back sharply in 1949 and 1950, increased by 9 percent in 1951. The very favorable market price for poultry meat in relation to eggs encouraged liquidation of flocks in Ireland, the United Kingdom, Norway, and possibly other countries.

The *outlook* for 1952 is for somewhat higher poultry meat production in nearly all reporting countries than in 1951, somewhat higher spring egg production in the United States and Canada and an increase in fall egg production in the United Kingdom. The feed situation does not appear favorable for increased egg production in the Scandinavian countries, Argentina and Australia and the price situation is not favorable in Ireland, the Scandinavian countries, and Australia.

* This is one of a series of regularly scheduled reports of world agricultural production approved by the Office of Foreign Agricultural Relations Committee on Foreign Crop and Livestock Statistics. It is based in part upon U.S. Foreign Service reports. (Foreign Agriculture Circular FPE 2-52, March 17, 1952. Office of Foreign Agricultural Relations, U.S. Dept. of Agr., Washington, D.C.)

While poultry meat production is expected to increase in the United States and Canada, the number of chicks raised this spring for laying flock replacements is expected to decline.

Egg production in *Canada* during 1951 totaled 364.6 million dozen (farm production was 333.4 million dozen) which represents a 9 percent increase over the 1950 production of 333.3 million dozen. The total Canadian chick hatch during the 1950-51 season (September-August) was up 34 percent over the 1949-50 season and was estimated to be 84 million birds. Poultry meat production during 1951 is estimated at 306 million pounds as compared to 296 million pounds in 1950.

Total egg and poultry exports were again drastically reduced with only 6.7 million dozen eggs (shell equivalent) and 1.2 million pounds of poultry meat being shipped from Canada during 1951. Egg exports to the United States in 1951 were 4,687,000 dozen compared to 4,709,988 dozen in 1950. During the first seven weeks of 1952, egg exports to the United States were 349,560 dozen compared to 1,984,140 dozen for the same period in 1951. However, total imports of fresh poultry from the United States to Canada in 1951 jumped to 6.6 million pounds as compared to 1.6 million pounds in 1950. Imports of eggs in 1951 were 3,330,000 dozen compared to 897,000 in 1950.

The current marketing situation for eggs and poultry remains good despite a recent drop in egg prices to near support level (38 cents per dozen). The effects of the expected 15 percent increase in poultry and egg supplies on prices will be somewhat offset by a continued strong domestic demand and Western Hemisphere exports.

In the *United States*, egg production in 1951 was very slightly above the previous record output of 1950. Egg consumption in 1951 was estimated at nearly 400 eggs per capita. Eggs sold in 1951 at prices generally considered favorable. The number of chickens raised during 1951 for laying flock replacement was about 5 percent over that of 1950 and the number of chickens on farms was 2.4 percent greater on January 1 in 1952 than in 1951. The number of broilers produced was a new record, probably 25 percent above 1950. Turkey production of 52.8 million birds in 1951 was a record high and a further increase is expected in 1952, largely due to the growing popularity of the Beltsville Small White breed which is suitable for year-round production. The larger

number of chickens on farms and the anticipated slight increase in rate-of-lay indicate a new record high egg output in 1952.

In *Austria,* poultry numbers and egg production continued to increase. The rate-of-lay, although improving, remained low because of scarce feed supplies and poor quality laying flocks. Imports of eggs in 1951 amounted to 50 million and were almost exclusively from Eastern Europe.

In *France,* egg production was at the same level as in 1950 but poultry meat production increased 2 percent. Prices for poultry and eggs were substantially higher in 1951 than in 1950. Net exports of eggs decreased from 26 million in 1950 to 10 million in 1951. Net exports of poultry dropped from 4.4 million pounds in 1950 to 1.9 million pounds in 1951.

In *Italy,* slowly rising prices for poultry and eggs together with increased supplies of poultry feed resulted in a moderate increase in poultry numbers and egg production. Imports of eggs by September of 1951 had reached 24 million, an increase of 38 percent over the total egg imports of 1950. Imports of live poultry was much higher than in 1950. A continuation in the rise of consumer purchasing power may result in an increase in consumption of eggs and poultry in 1952. Much of any such increase would have to be imported but gains in domestic production are anticipated.

In *Western Germany,* total poultry numbers were up 5 percent in 1951, laying hens increased by 10 percent, and egg production was up by nearly 20 percent as compared to 1950. Poultry meat production for 1951 is estimated at 110 million pounds. Imports of fresh eggs of about 1.4 billion eggs, mainly from the Netherlands and Denmark were less than the 1.9 billion eggs imported in 1950. Imports of poultry meat of 13 million pounds were 21 percent lower than in 1950.

In the *Netherlands,* egg production in 1951 was 17 percent over that of 1950 although the number of hens and pullets increased less than 1 percent. The increased production from about the same numbers of layers is partially explained by the killing of older and less productive hens for meat and their replacement with pullets. The high feed prices and tightening supplies encouraged the trend toward higher productivity per hen. The effect of the reduced Government subsidy on imported feed and bran has been offset by the removal of the export levy on eggs. Exports in 1951 amounted to 1,247 million eggs as compared to 1,069 million in 1950 and 441 million in 1949. In 1949 the United King-

dom took nearly 60 percent of the shell egg exports, in 1950 less than 2 percent, and in 1951 a negligible amount. Western Germany has been the largest taker in 1950 and 1951 with 88 percent of the total egg exports. In 1951 exports of eggs to Canada and the United States amounted to 15 million and 32 million respectively. For 1952, the egg and poultry outlook seems stable with the feed shortage being the biggest problem.

In *Switzerland,* production of eggs increased slightly despite a small decrease in numbers of layers due to an increase in the rate-of-lay. Consumption of shell eggs increased but that of frozen and dry eggs declined. Imports of dressed poultry were complicated by veterinary controls for Newcastle disease. Imports of eggs in 1951 of about 205 million were slightly above those of 1950. Of total imports, France, Denmark, and the Netherlands supplied about two-thirds in 1951. Imports from the United States, which accounted for 5 percent of the total in 1950, were negligible in 1951. Indications are that production, consumption and imports of eggs will change little in 1952.

In *Belgium,* poultry numbers and egg production declined in 1951 due partly to an outbreak of poultry plague but mainly due to the low prices which farms received for poultry and eggs in relation to feed prices. Belgium both imports and exports eggs; in 1951, net exports were 25 million eggs as compared to net exports of 92 million in 1950.

In *Denmark* poultry numbers and egg production in 1951 was about 11 percent below that of 1950. The reduction in poultry numbers was due to low egg prices in relation to high grain prices and the very good prices for poultry meat. For the first nine months of 1951 as compared to the same period of 1950 exports of eggs decreased 20 percent, from 1,144 million to 915 million. Large quantities of eggs were placed in storage for later export. Exports of dressed poultry during the first nine months of 1951 increased to 14 million pounds as compared to 9 million for the same period in 1950.

In *Norway,* both the number of adult birds and egg production were less in 1951 than in 1950. Despite a 25 percent higher level of egg prices in 1951 the egg feed price ratio was not favorable enough to encourage increased output and feed supplies were limited. It is the policy of the Norwegian Government to encourage egg production (by allocation of feed supplies) only to the extent necessary to meet

domestic requirement. Storage facilities are insufficient to carry the surplus from the two peak production periods, in December and January and again in May and June, until the fall and early winter period of short supplies. Thus, Norway exports small quantities of shell eggs each year during the periods of peak production. Since postwar exports began in January 1950, they have gone almost exclusively to Western Germany which offers an outlet for eggs of small size for which there is little demand in Norway. Exports in 1951 amounted to about 13 million eggs as compared to 22 million in 1950. It is expected that numbers of adult chickens and, consequently, egg production will show a slight increase in 1952 due to the increased number of young chickens raised in 1951.

In *Sweden*, the number of layers and egg production in 1951 were both down slightly from 1950 levels. Production of poultry meat, mostly old hens and roosters, was estimated as 22 million pounds in 1951. Exports of eggs in 1951 of 150 million were down considerably from the 215 million exported in 1950. Most of these eggs were exported to Western Germany. The number of chicks raised in 1951 was slightly above that of 1950. Despite the relatively tight supplies of feed, it is expected that, due to slightly larger chicken numbers and an anticipated slight increase in the rate-of-lay, egg production in 1952 will be somewhat above that of 1951.

In *Ireland*, poultry numbers and egg production in 1951 were down 12 and 20 percent respectively from 1950. Unfavorable export price arrangements for eggs depressed the poultry industry and caused curtailment of laying hens. Egg exports in 1951 of 220 million were just over half of the 402 million exported in 1950. By contrast with the egg situation, poultry meat production was profitable especially for turkeys and table cockerels. It was estimated that poultry exports would total about 25 million pounds as in 1950. It is expected that both poultry numbers and egg production will continue downward in 1952.

In the *United Kingdom*, egg production during 1951 was below that of 1950 due to the 5 percent lower rate of output during the first half of the year. Production levels were up 2 percent during the last half of 1951 and are expected to remain high during the first part of 1952. Per capita consumption of 254 eggs in 1950 was above that of 228 eggs in prewar years, but total supplies of eggs in 1951-52 are expected to be somewhat below those of the previous years. Imports of

eggs are expected to be reducd in the coming year. However, with weekly ration of one or two eggs during much of the year, it would appear that imports might be increased if an adequate storage program could be arranged so as to take advantage of obtaining seasonal surpluses of eggs from soft currency countries.

In *Greece,* egg production was down 4 percent although chicken numbers were up 16 percent as compared to 1950. The decrease in egg production was due to the fact that Newcastle disease sharply reduced the number of older laying hens and their rate-of-lay and new flocks had not come into full production. The outlook for increased production in 1952 is not favorable since feed supplies are not improving.

In *Turkey,* chicken numbers in 1951 were about at the 1950 level but egg production was up slightly. Throughout most of the country, poultry keeping is a family backyard business with flocks of one to two dozen fowls of mixed breeding which depend largely upon their own efforts to scratch out a living from waste grain and refuse. The average production per layer is estimated at about four dozen eggs per year, except around the Black Sea and Mamara area where egg production is on more of a commercial basis and more attention is given to poultry care and management. Turkeys estimated to number 1.2 million birds in 1950, are generally herded in flocks over the fields for feeding on waste grain, weed seeds, grass and insects. They are driven, often 12 miles or more, to market centers at Christmas and New Year's and sold alive from door to door and to butcher shops.

In *French Morocco,* indications are that poultry numbers have increased fairly steadily since 1947, when local epidemics of Newcastle disease decreased in severity after several bad years. Total egg production in 1951 is estimated at about 500 million eggs or slightly above that of 1950. About 50 percent of total egg production is commercialized. Exports which have ranged from 70 to 100 million eggs during postwar years were down about 20 percent in 1951 from 1950. Not much change in the poultry and egg situation in 1952 is expected since Newcastle disease remains prevalent and feed costs are increasing along with increases in the prices of poultry and eggs.

In the *Philippine Republic,* the poultry industry continued to make substantial progress with numbers of all poultry estimated at 32.9 million (of which chickens account for 32.0 million) or 26 percent above prewar. The chicken, duck and geese

flocks have already exceeded 1939 numbers and only turkey flocks are below prewar. With egg imports being progressively reduced by import controls, commercial poultry farming has grown by leaps and bounds and egg production in 1951 was 40 percent above prewar levels. Both eggs and poultry meat are expected to continue in good supply in 1952.

In *Argentina*, egg production in 1951 was about 4 percent higher than in 1950 since the increased number of laying hens more than offset the reduction in rate-of-lay which resulted from short grain supplies and poor foraging. There is the possibility of an egg shortage during the first half of 1952 since stocks are down about 40 percent under last year and the out-of-storage movements are heaviest during February-July. Exports of eggs during 1951 totaled nearly 3 million, about 50 percent above those of 1950. Exports in the first part of 1952 have been negligible and no sizable shipments are expected before September. Exports of frozen poultry were about 1.4 million pounds in 1951 and are expected to increase in 1952. Turkey receipts at the Buenos Aires market were down nearly 20 percent in 1951 from the 3.5 million pounds of 1950 but the cold-storage pack of 2 million pounds was about the same as in 1950. Exports of turkey in both 1950 and 1951 amounted to 2.5 million pounds and are expected to remain at this level during 1952.

In the *Union of South Africa*, production of eggs and poultry in 1951 was at higher levels than in the previous season. Prices increased in relation to the increase in the controlled price of corn. Supplies of feed were adequate. The general meat shortage continued to offer encouragement to the poultry industry. Turkey production had a favorable year in 1951 after recovering from a serious financial set-back in 1950. Poultry flocks were free of significant diseases. Government control measures during the Newcastle epidemic in 1950 were quite effective and only isolated cases appeared in 1951. The export market, aided by improved quality of eggs, took nearly twice as many shell eggs in 1951 as in 1950 when exports were estimated about 25 million eggs. The demand for poultry and eggs in 1952 appears strong but production may be hindered due to short supplies of feed since the current crop of corn is suffering from extended drought.

In *Australia*, the production of eggs continue to decline since prices on both domestic and foreign markets have not kept pace with increasing costs of production. Food stuffs are not only relatively high in price but also increasingly difficult

CHICKENS

Numbers in specified countries, average 1934-38, annual 1948-1952

Continent and Country	Date Applicable	Average 1934-38	1948	1949	1950	1951	1952 Preliminary
		Thousands	Thousands	Thousands	Thousands	Thousands	Thousands
North America							
Canada	Dec. 1	44,077	47,310	37,169	39,319	34,277	37,350
United States	Jan. 1	408,177	449,644	430,876	456,549	442,657	453,498
Mexico	March	[2]36,368	—	—	—	—	—
Cuba	July	—	9,000	8,500	9,000	8,500	—
Dom. Republic		2,358	—	2,000	2,000	2,000	—
Guatemala		[3]664	—	—	3,500	3,500	—
Panama		[3]195	—	1,400	1,400	—	—
Europe							
Austria	Dec. 3	[3]8,862	5,800	5,600	6,100	7,500	7,700
Belgium	Dec. 31	16,500	13,500	16,100	16,300	16,500	15,000
Denmark	July	[3]27,643	23,445	25,996	24,548	22,110	—
Finland[4]	Sept. 1	2,853	1,918	2,668	2,880	2,880	—
France	Fall	[5]145,000	—	—	75,000	—	—
Germany (West.)	Dec.	51,225	25,500	29,000	39,957	48,064	50,600
Greece[6]	Nov. 30	11,679	8,625	9,700	9,700	8,991	10,500
Ireland	June	15,961	17,079	18,524	17,983	15,956	—
Italy	Dec.	76,000	—	—	—	62,500	65,000
Luxembourg	Dec.	[3]515	380	400	400	400	—
Netherlands	Dec.	[7]29,632	8,500	9,843	10,584	15,676	15,817
Norway	June 20	5,686	4,663	6,743	4,985	4,689	—
Portugal	Dec. 31	[8]5,716	—	—	—	—	—
Spain	July 1	[9]28,972	37,200	33,500	35,000	—	—
Sweden	[11]	10,980	14,023	12,448	12,061	12,118	—
Switzerland	April	[8]5,544	5,900	6,100	6,300	6,238	—
U. Kingdom Farm	June	73,402	79,219	89,152	90,789	90,067	—
Total	June	—	—	—	—	—	—
Yugoslavia	Dec. 31	18,021	—	—	—	—	—
Asia							
Lebanon	Dec.	—	1,000	992	994	995	700
Palestine		[3]1,914	—	—	—	—	—
Syria		1,525	2,235	2,447	2,482	—	—
Turkey		16,794	18,614	18,955	20,222	20,112	—
China		265,765					
Japan	July	51,094	[12]17,688	[13]16,356	[13]19,907	—	—
India		—	—	—	62,600	62,200	—
Pakistan		—	—	—	—	—	—
Phil. Islands		25,365	21,911	26,000	30,000	32,000	—
South America							
Argentina	June	[14]42,988	—	—	47,500	58,000	66,000
Brazil		[15]59,000	60,000	60,000	—	—	—
Chile	June	[3]1,026	—	—	—	—	—
Paraguay		—	—	—	2,400	—	—
Peru		—	—	—	9,500	—	—
Uruguay		[12]4,814	3,952	3,752	—	—	—
Africa							
Egypt	July	[8]26,889	—	—	—	—	—
French Morocco		[3]50,000	—	—	—	—	—
U. South Africa[4]	Aug.	14,000	16,000	15,700	16,000	16,500	—
Oceania							
Australia	Dec. 31	15,541	—	—	—	—	—
New Zealand	March	[8]3,489	—	[17]4,600	[17]4,600	[17]4,600	—

1 Year end estimates (October-December) shown under following year for comparison. Thus for Canada, the December 1, 1951 estimate is shown under 1952. 2 1940. 3 Average for 2 to 4 years only. 4 Adult poultry. 5 Represents chickens raised. 6 All poultry. 7 June. 8 1936. 9 1939. 10 April. 11 September 1937, June 1946-1949, April 1950-51, census estimates include layers and chicks. 12 August. 13 February. 14 1937. 15 1938. 16 1945. 17 Estimated.

EGGS

Number produced[1] in specified countries, average 1934-38, annual 1946-1951

Continent and country	Average 1934-38	1946	1947	1948	1949	1950	1951
	Million	Million	Million	Million	Million	Million	Million
North America							
Canada—Farm	2,638	3,883	4,484	4,274	3,774	3,662	4,001
Total	2,863	4,228	4,889	4,663	4,126	4,003	4,376
United States—Farm	35,498	55,590	55,252	55,158	56,629	60,046	60,100
Cuba	320	300	288	276	318	320	——
Dominican Republic	——	60	60	60	60	60	60
Guatemala	——	——	——	——	——	90	——
Panama	——	——	52	——	54	——	——
Europe							
Austria	663	270	285	350	400	540	640
Belgium	1,693	1,100	1,380	1,440	1,900	2,100	1,945
Denmark	1,979	883	992	1,392	1,870	2,100	1,900
Finland	317	93	117	176	266	317	267
France	6,200	6,200	6,300	6,100	6,800	7,500	7,500
Germany (Western)	3,700	2,150	1,975	2,250	2,800	4,100	4,900
Greece	550	349	376	384	390	440	423
Ireland	1,086	801	733	844	1,014	1,073	855
Italy	5,500	3,600	4,300	4,450	4,550	5,000	5,225
Luxembourg	40	——	30	35	40	40	40
Netherlands	1,978	480	1,052	1,159	1,480	1,775	2,075
Norway	369	155	198	263	340	459	391
Portugal	250	——	——	——	——	——	——
Spain	1,700	——	1,992	1,800	1,800	1,920	1,980
Sweden	1,000	1,149	1,217	1,335	1,331	1,407	1,390
Switzerland	423	391	442	520	559	520	525
United Kingdom:							
Farm[2]	[3]3,871	2,418	2,600	3,000	3,500	——	——
Total[2]	[3]5,098	3,850	4,000	4,300	5,000	5,800	5,600
Yugoslavia	1,000	——	——	——	——	——	——
Asia							
Lebanon	——	65	60	48	42	45	40
Palestine	108	200	——	——	——	——	——
Syria	92	120	90	110	70	90	——
Turkey	1,003	863	895	840	840	856	——
Japan	3,553	618	663	790	1,214	1,568	——
India	——	2,794	——	——	——	1,082	——
Pakistan	——	571	——	——	——	——	——
Philippine Islands	——	240	400	605	652	740	900
South America							
Argentina	1,127	——	——	——	——	2,750	3,000
Brazil	——	——	——	200	200	——	——
Chile	——	520	460	370	400	400	——
Paraguay	——	——	100	110	120	120	——
Peru	——	——	——	——	——	——	——
Uruguay	289	358	326	330	300	300	——
Africa							
Egypt	751	——	——	——	——	——	——
French Morocco	1,000	——	——	——	——	——	500
Union of S. Africa[4]	——	——	——	——	1,200	840	960
Oceania							
Australia[5]	708	1,358	1,470	1,431	1,443	1,388	1,288
New Zealand	430	[6]153	[6]134	[6]135	[6]140	[6]170	[6]180

[1] Farm production in United States but data for many countries not explicit on this point. [2] Years ending May. [3] Three-year average. [4] Years ending June. [5] Commercial production for years ending June 30. [6] Receipts at Marketing Department Stations, year ending March, which account for 30-40 percent of total production.

to secure. This situation will probably be intensified this year because the 1951-52 wheat, corn and sorghum crops are below last year's levels. Another factor contributing to lowered egg production has been the swing in recent years to poultry meat production because of more advantageous prices. Exports of eggs during the 1950-51 season amounted to 350 million as compared to 444 million during 1949-50.

In *New Zealand,* poultry numbers are estimated at 4.6 million of which 90 to 95 percent are laying birds. Receipts of eggs at Marketing Department stations have increased steadily during postwar years and are estimated to account for 30 to 40 percent of total egg production. New Zealand is a deficit egg producing country and imports 20 to 30 million eggs annually from Australia.

SWEET POTATO ROOT MEAL VERSUS YELLOW CORN MEAL IN THE CHICK'S DIET*

M. M. ROSENBERG AND JAMES SEU

Department of Poultry Husbandry, College of Agriculture
University of Hawaii, Honolulu, Hawaii

Certain indigenous and introduced plant species, recognized for their carbohydrate value, can be raised in the tropics to much better advantage than corn, but little is known of their usefulness in poultry rations. Of these, sweet potato root meal has received the most intensive attention. Seagar (1930) has reported that the starches in raw sweet potato, among others, caused digestive disturbances when fed to certain animals in large quantity, and that cooking or heating of the tubers in the presence of water dextrinized the starches and thereby eliminated this problem. Lease and Mitchell (1940) found that dehydrated sweet potato was a "potent" source of vitamin A activity. Chicks stored "considerable" vitamin A in their livers when fed a vitamin A-low ration plus sweet potato flour. And Tillman and Davis (1943) have reported that 10 and 20 percent of yellow corn meal may be successfully replaced by sweet potato meal in chick rations. Diets containing higher levels did not produce as satisfactory results. They concluded that sweet potato meal was a good carbohydrate in practical chick rations when fed within designated limits.

---

* Published with the approval of the Director of the Hawaii Agricultural Experiment Station as Technical Paper No. 255.

This investigation was undertaken to procure additional data on the carbohydrate value of sweet potato root meal in the chick's diet.

MATERIALS AND METHODS

Uncured, uncooked dehydrated sweet potato root meal was prepared by slicing newly unearthed roots and dehydrating the chips in an electric oven at approximately 150°F. When dry, the chips were ground and screened (1/16-inch screen) in a hammer mill and stored in 4-ply paper bags at room temperature. In Experiment 1, this meal was substituted on a pound for pound basis for yellow corn meal in the series of rations shown in table 1. These rations were fed for 21 days to straight-run, day-old New Hampshire chicks housed in battery brooders on ½-inch wire-fabric floors.

TABLE I
Rations fed in Experiment 1

Ingredients	Unit	Rations						
		1	2	3	4	5	6	7
Sweet potato root meal*	lb.	0	7.5	15.0	22.5	30.0	37.5	45.0
Ground yellow corn	lb.	59.5	52.0	44.5	37.0	29.5	22.0	14.5
Fish meal (herring)	lb.	5.0	For all rations					
Soybean oil meal	lb.	29.5						
Dehydrated alfalfa meal	lb.	4.0						
Defluorinated phosphate	lb.	1.5						
Salt	lb.	0.5						
Manganese sulfate	gm.	11.0						
Delsterol (2000 AOAC/gm)	gm.	30.0						
Choline chloride	gm.	225.0						
Aurofac†	gm.	200.0						
Riboflavin	mg.	100.0						
Niacin	mg.	600.0						
Calcium pantothenate	mg.	300.0						

* Raw, uncooked meal processed within 48 hours after harvest.

† Aurofac (Lederle)—guaranteed minimum potency of 1.8 mg. B_{12} and 1.8 gm. aureomycin per pound.

In Experiment 2, a supply of fresh sweet potato roots was randomized into four lots and treated as follows:

Lot 1 (uncured, raw): sliced, dehydrated, and ground.

Lot 2 (uncured, cooked): boiled in water until soft, mashed, dehydrated, and ground.

Lot 3 (cured, raw): stored in burlap sacks for 10 days, then sliced, dehydrated, and ground.

Lot 4 (cured, cooked): stored in burlap sacks for 10 days, cooked in boiling water until soft, mashed dehydrated, and ground.

These meals were substituted for yellow corn meal at two concentrations as shown in table 2. As in Experiment 1, these rations were fed for 21 days to straight-run, day-old New

Hampshire chicks. In both tests, 16 chicks were randomized into each experimental group.

The sweet potato utilized in this study is named Ono Lena. It is a Puerto Rican type; i.e., a moist, high dextrin sweet potato.

TABLE II

Rations fed in Experiment 2

Ingredients	Unit	Rations								
		1	2	3	4	5	6	7	8	9
S.P.R.M.* raw, uncured	lb.	—	22.5	45.0	—	—	—	—	—	—
S.P.R.M. raw, cured	lb.	—	—	—	22.5	45.0	—	—	—	—
S.P.R.M. cooked, uncured	lb.	—	—	—	—	—	22.5	45.0	—	—
S.P.R.M. cooked, cured	lb.	—	—	—	—	—	—	—	22.5	45.0
Ground Yellow corn	lb.	59.5	37.0	14.5	37.0	14.5	37.0	14.5	37.0	14.5
Fish meal (herring)	lb.	5.0								
Soybean oil meal	lb.	29.5								
Alfalfa leaf meal	lb.	4.0								
Defluorinated phosphate	lb.	1.5								
Salt	lb.	0.5								
Manganese sulfate	gm.	11.0								
Delsterol (2000 AOAC/gm)	gm.	30.0				For all rations				
Choline chloride	gm.	225.0								
Aurofac†	gm.	200.0								
Riboflavin	mg.	100.0								
Niacin	mg.	600.0								
Calcium panthothenate	mg.	300.0								

* S.P.R.M.—sweet potato root meal.

† Aurofac (Lederle)—guaranteed minimum potency of 1.8 mg. B_{12} and 1.8 gm. aureomycin per pound.

RESULTS

Experiment 1. There was a progressive retardation in growth rate among the experimental groups as the concentration of uncured, uncooked sweet potato root meal was increased. Furthermore, with the exception of ration 3 (15.0 per cent potato root meal), as the concentration of this meal was increased the efficiency of feed utilization decreased. Upon analysis, using individual body weights within each experimental group, it was found that the reduction in growth rate was highly significant ($P < 0.01$), whereas the within treatment variation was not significant ($P > 0.05$). The least significant difference for average body weights of the experimental groups was 15.59 grams; indicating, thereby, that even at 7.5 percent uncured, uncooked sweet potato root meal significantly impaired growth rate. The diets containing 37.5 and 45.0 percent potato meal supported significantly poorer

growth rates than those containing 7.5, 15.0, 22.5 and 30.0 percent of this meal. The body weight index for each experimental group, based on the controls' weight, is also shown in table 3 for easier comparison.

TABLE 3

Economy of feed utilization and percentage gain as affected by treatments (experiment 1).

Rations	Body wts. at 3 weeks (gm.)	Feed consumption (gm.)	Unit feed per unit gained	% gain based on controls' gain
1	282.3	439.8	1.82	100.0
2	256.6	416.1	1.96	90.8
3	250.3	383.0	1.78	88.6
4	244.0	404.3	1.99	86.4
5	244.7	418.5	2.05	86.6
6	216.1	383.0	2.18	76.5
7	190.5	354.6	2.37	67.5

Between rations $F = 15.98$ $P < 0.01$
Within rations $F = 0.89$ $P > 0.05$
L.S.D. between rations = 15.59 gm.

Experiment 2. At either concentration, 22.5 and 45.0 percent of total diet, sweet potato root meal, regardless of method of preparation, significantly impaired the growth of chicks to 3 weeks of age. Upon analysis, a highly significant F value was obtained between rations, while the within treatment variation was again not significant. In every comparison, regardless of method of preparation, the addition of 45.0 percent sweet potato meal significantly reduced growth rate below that of the respective groups fed 22.5 percent of these meals.

Among the groups fed 22.5 percent sweet potato root meal, either curing or cooking, or both, significantly improved the feeding value of the meal. As may be seen in table 4, treatments 4 (cured, uncooked), 6 (uncured, cooked), and 8 (cured, cooked) resulted in greater gains than that obtained from treatment 2 (uncured, uncooked). At the 45.0 percent concentration, however, the cooked potatoes were significantly superior to both (uncured, uncooked) and (cured, uncooked) groups.

As in Experiment 1, none of the rations containing sweet potato root meal was as efficient as the control. In all instances the rations containing 22.5 percent were more efficient than the rations containing 45.0 percent of these meals.

There was no mortality among the 256 chicks employed in this study.

DISCUSSION AND CONCLUSIONS

According to Culpepper and Magoon (1926), sucrose was

TABLE 4

Economy of feed utilization and percentage gain as affected by treatments (experiment 2)

Rations	Body wts. at 3 weeks (gm.)	Feed consumption (gm.)	Unit feed per unit gained	% gain based on controls' gain
1	234.4	400.0	2.00	100.0
2	196.6	400.0	2.49	83.0
3	182.7	400.0	2.69	77.9
4	218.0	394.4	2.14	93.0
5	183.0	407.1	2.73	78.1
6	220.5	396.5	2.12	94.1
7	197.5	465.3	2.84	84.2
8	218.7	445.5	2.41	93.3
9	199.9	439.8	2.65	85.2

Between rations $F = 9.21$ $P < 0.01$
Within rations $F = 2.28$ $P > 0.05$
L.S.D. between rations = 10.51 gm.

the most abundant sugar in the raw sweet potato (Puerto Rico). They observed, after cooking this variety, a great increase in the reducing sugars, particularly maltose, and a reduction in starch. When the sweet potato was cured for 8 to 10 days, they noted a slight increase in sucrose and a slight decrease in starch. Unfortunately, no data were included on the changes in the reducing values when this variety was cured and not cooked. Since no chemical analysis was available on the variety we employed, it is not known to what extent the carbohydrates were modified by either curing or cooking, or both. One may keep in mind, however, that Ono Lena is a Puerto Rican type sweet potato that was derived originally from a cross between the varieties Puerto Rico and Nancy Hall. Both are considered to be of the moist, high dextrin type, as is Ono Lena.

The data obtained in this investigation indicate that changes beneficial to the chick were induced in the sweet potato by either curing or cooking, or both. Apparently, the carbohydrates in the uncured sweet potato are not readily digested in the alimentary canal of the chick. Two questions are raised by these data, moreover, that require further investigation. First, why did the chicks fed cured, uncooked sweet potatoes grow as well as those fed cooked potato meal? According to the data presented by Culpepper and Magoon (1926), the sugar content, particularly maltose, was much higher and the starch much lower in the uncured, cooked Puerto Rican sweet potato than in those cured and uncooked. Second, why did the chicks fed 22.5 percent sweet potato meal (either cooked or cured, or both) grow better than the chicks fed 45.0 percent of the respective meals? The data suggest that the higher levels of sweet potato meal provided an excess

of fiber, thereby reducing the nutritive value of the experimental diets. Ewing (1951) in his review has stated that crude fiber is poorly digested by the chicken.

This study has failed to confirm certain findings reported by Tillman and Davis (1943). They were able to feed 10 and 20 percent sweet potato meal to 10 weeks of age with results comparable to those of the control chicks. Unfortunately, neither the variety they used nor the method of preparation was indicated. Therefore, the results of our study are not necessarily in conflict, since it is possible that the various varieties of sweet potatoes differ in their feeding values. It would appear, therefore, that a comparison of feeding value of the many varieties of sweet potato is desirable.

Within the limits of this experiment, sweet potato root meal was inferior to corn as a source of carbohydrates. However, when cured, cooked, or both, growth gains were obtained that were significantly superior to those obtained from the raw, uncooked sweet potato root meal.

SUMMARY

Dehydrated sweet potato root meal produced from freshly unearthed tubers gave significantly poorer results than yellow corn meal when fed to day-old New Hampshire chicks for 3 weeks at levels ranging from 7.5 to 45.0 percent of the experiment diets. When cured or cooked, or both, the nutritive value of sweet potato root meal was significantly improved; however, these meals, when fed at 22.5 and 45.0 percent of the chicks' rations, still failed to support growth as well as did yellow corn meal. In all instances the rations containing 22.5 percent of either cured or cooked, or cured and cooked meals produced superior gains and were more efficient than rations containing 45.0 percent of the respective meals. There was no significant difference in the gains induced by either cured or cooked sweet potato root meal.

REFERENCES

Culpepper, C. W., and C. A. Magoon, 1926. The relation of storage to the quality of sweet potatoes for canning purposes. *Jour. Agr. Res. 33*, 627-644.

Ewing, W. R., 1951. *Poultry Nutrition*, W. Ray Ewing, Publisher, Box 248, South Pasadena, California.

Lease, E. J., and J. H. Mitchell, 1940. Biochemical and nutritional studies of dehydrated sweet potato. *South Carolina Agr. Exp. Sta. Bull.* 329, 1-15.

Seagar, E. A., 1930. Defective diet. Notes on the feeding of indigenous rats on tannia and other tubers, with special reference to the question of toxic effects. *Tropical Agr.* (Trinidad) 7, 120.

Tillman, A. D., and H. J. Davis, 1943. Studies on the use of dehydrated sweet potato meal in chick rations. *Louisiana Agr. Exp. Sta. Bull.* 358, 1-11.

NEWCASTLE DISEASE*

E. C. LLOYD
Animal Health Division, Ministry of Agriculture and Fisheries, Hook Rise, Tolworth, Surbiton, Surrey, England

The first appearance of Newcastle disease in this country was at Newcastle-on-Tyne in 1926. It was given its name by Doyle who recovered the causal virus. The origin of the outbreak was attributed to the feeding of poultry on swill from the port and infection was of a virulent type causing high mortality. Further outbreaks occurred in England in 1927, but after that year the disease did not appear again until 1933.

In 1933 a single outbreak occurred on a large poultry farm in Hertfordshire. Here again, high mortality was a feature of the outbreak. The owner voluntarily slaughtered all birds on the farm and disease did not spread to other premises. The source of infection in this outbreak could not be ascertained.

Up to this time the Minister of Agriculture had no power to apply compulsory measures against poultry diseases, and the diagnosis and control of Newcastle disease depended upon owners who, confronted by illness and mortality in their poultry, consulted the Ministry and voluntarily carried out the control measures suggested to them.

In 1935, the Diseases of Animals Acts were extended to apply to poultry, and under these new powers in 1936 an Order entitled the Fowl Pest Order was made making the two poultry diseases, Newcastle disease and fowl plague, notifiable, and providing for compulsory slaughter and compensation. Thus the decision was made to pursue an eradication policy against fowl pest by slaughter should it again appear. The country, however, remained free from the disease from 1933 until February 1947.

On 22nd February 1947, Newcastle Disease was confirmed in Somerset, and other outbreaks quickly followed rising to a peak in June with a figure of 209 outbreaks confirmed that month. Enquiries into the source of infection revealed that in many of these outbreaks poultry had had access to unboiled swill which frequently contained poultry waste, intestines, heads, feet, etc., from poulterers shops. The importation of table poultry carcases from Europe which

* Paper delivered at the Fifth Annual meeting of the United Kingdom Branch of the Worlds Poultry Science Association, London, England, March 21, 1952.

had been discontinued during the war years had recently been resumed, but the disease situation on the Continent had undergone a profound change in the meantime. Some of the supplying countries—notably Hungary and Poland—had been invaded and over run by Newcastle disease and it was soon realized that infection was being introduced with poultry carcases imported from Europe. Multiple centers of infection were thus set up in our own flocks, and disease was rapidly spread by the movement of live birds by dealers and through markets.

Four measures were employed to cope with the situation.

(1) The slaughter of diseases and contact birds.

(2) Stringent restrictions on the marketing and movement of poultry.

(3) Extension of the Boiling of Animals Foodstuffs Order to apply to poultry.

(4) Evisceration of all poultry carcases imported from Europe. (By arrangement with the Ministry of Food which was the sole importer).

The rate of mortality caused by the disease was variable, in some cases reaching nearly 100 per cent, and in others being comparatively low. Diagnosis in most cases, however, could be made from clinical symptoms and post-mortem findings.

The incidence of outbreaks fell between June and August but rose again in September and October to reach a new peak figure of 665 in November. By the end of 1947 a total of 2,222 outbreaks had been recorded. Of these 2,168 were distributed in 45 counties in England—the heaviest infection being in the counties round Birmingham and London, and the Eastern counties. 54 outbreaks occurred in 6 counties of Wales, but Scotland remained free from infection. The movement of live poultry into Scotland and parts of Northern England from the rest of England and Wales was prohibited by an Order issued on 6th August 1947.

The epizootic reached its peak in November 1947 and by the beginning of 1948 it was rapidly abating. In April only 12 outbreaks were recorded. During that year disease was brought well under control and the September, October and November figures were 9, 3 and 2 respectively. The total outbreaks in 1948 numbered 267, of which only 9 were in Wales, and 1 in Scotland; the Scottish outbreak being caused by the illegal movement of live poultry from England.

In the Spring of 1949 disease again took an upward trend in England, and by June a monthly figure of 65 was

reached. A high proportion (about 75 per cent) of these outbreaks were primary, i.e. no connection with any other outbreak could be traced, and over 60 per cent occurred on premises of domestic poultry keepers. These outbreaks were distributed widely over the country and enquiries showed that in about half of them there was an association with swill which could have contained or been contaminated with imported poultry carcases. This suggested that evisceration of carcases prior to their importation from infected European countries had not eliminated the danger of introducing infection.

The virus of Newcastle disease in affected birds is not confined to the viscera, and samples taken from the skin of imported frozen eviscerated carcases at Smithfield had been shown to contain the virus. It had been hoped that evisceration of imported carcases would effectively prevent them setting up the disease in this country as it was expected that the whole carcase would be cooked as received and the virus thus be destroyed. It was found, however, that the handling and washing of imported carcases—particularly in the kitchens of domestic poultry keepers—led to the contamination of kitchen waste (e.g. green food) fed to poultry. Also parts of carcases were trimmed off and got into the swill which reached the poultry unboiled.

The disease in Hungary at this time was very widespread, and a visit to that country in July by veterinary officers from Great Britain showed that birds brought to the killing plants were kept alive in very close contact for final feeding for about a week. This enabled disease to build up at these plants, and greatly increased the danger of birds picking up infection before they were slaughtered. Our need to import food did not at that time permit the complete banning of poultry supplies from all infected countries, therefore arrangements were made with the Hungarian Government, and later with the Polish Government by which steps were taken in those countries to reduce the likelihood of diseased birds being slaughtered and sent to Great Britain. The arrangement with the Ministry of Food whereby poultry carcases from Europe were eviscerated before shipment was continued, and, in addition, that Department agreed to confine the distribution of such carcases to five mainly urban areas where there was less risk that infection would spread to large poultry flocks.

During the last half of 1949, outbreaks in England and Wales rapidly declined; the September, October and Novem-

ber figures being 11, 2 and 1 respectively. This closely followed the experience in 1948 and coincided with the seasonal fall in the use of imported supplies. The 1949 total for England and Wales was 379, but to this must be added 203 outbreaks confirmed in Scotland which brings the figure for Great Britain that year to 582.

Scotland. A new feature in 1949 was the appearance of Newcastle disease in Scotland. That country had hitherto remained free from the disease, apart from the single outbreak in Midlothian in 1948 already referred to, which was caused by illegal movement of live poultry from England. Disease was first confirmed in two flocks in the Orkney Islands on 6th September and enquiries soon revealed others, the oldest of which appeared to have commenced as early as 9th August. Disease quickly spread along the north-west coast to the Inner and Outer Hebrides, and a few outbreaks occurred on the east coast near the sea as far down as the Bass Rock. Three outbreaks were also recorded in Shetland. Extensive enquiries failed to reveal conclusively the source of the infection in Orkney but it is thought that it must have arisen from infected material discharged from a passing vessel.

It was known that more than a hundred infected carcases were dumped into the sea from the two outbreaks confirmed on 6th September and the widespread distribution of these Scottish outbreaks in the Orkneys, Hebrides and the coastal districts of the mainland strongly suggested that sea birds were responsible for the spread of infection. Water birds are not normally found to show clinical signs of Newcastle disease, but geese and ducks do harbour the virus and have been shown to pass on infection. The virus has frequently been isolated from imported geese carcases. Efforts were made to obtain sea birds from the Scottish districts concerned and the virus was recovered at Weybridge and Lasswade from shags and cormorants. It seems fair to conclude that the repeated baiting of sea birds by the dumping of infected poultry carcases into the sea enabled the infection to take hold, at least temporarily, in sea birds and they played a part in the upkeep of the virus as well as in its mechanical transmission. The greatest number of outbreaks occurred in the Hebrides where it took considerable time to secure the safe disposal of diseased poultry carcases, and infection spread down the west coast of Scotland and ultimately caused a few outbreaks in Ireland near the north-east coast.

The peak of the Scottish epizootic was reached in October with 100 outbreaks that month and by the end of the year 203 outbreaks had been recorded. Although outbreaks continued into 1950, chiefly in the Hebrides, they came to an end in August—about 12 months after the commencement, and 21 outbreaks were added to the 1949 total. The disease did not appear again in Scotland until January 1951.

In England and Wales the incidence of Newcastle disease remained low throughout the first half of 1950. Of the 66 outbreaks in England 32 were in the zoned areas receiving imported European poultry carcases, 12 were in Cornwall and originated from ships' swill from Falmouth and the remaining 22 were in counties adjacent to the zoned areas. This, coupled with the results achieved in Scotland, indicated that apart from disease resulting from the continued importation of infection with imported poultry carcases, slaughter and control of movement had gone a long way to eradicate the disease. Wales had only 2 outbreaks which were in the zoned area in Glamorganishire.

Up to this period little difficulty had been experienced in recognizing Newcastle disease clinically since although outbreaks varied considerably in mortality and drop in egg yield, symptoms were generally sufficiently typical to lead to early recognition and poultry owners had become alive to their responsibilities and were freely reporting suspected cases.

Apart from continued importation there existed another threat to successful eradication. This was the likelihood of the disease taking a less recognizable form. It was known that this could occur in Newcastle disease, indeed in U.S.A., and elsewhere such a form is commonly seen. This milder or less acute form of the disease may be associated with little or no mortality. There may be moderate or temporary drop in egg yield and some birds may seem dull and have ruffled feathers. A watery discharge from the nostrils is sometimes seen with sneezing and shaking of the head, difficulty in breathing accompanied by a "gurgle" in the throat may be noticed and there may be greenish diarrhea or only pasting of the vent feathers. These symptoms may be very slight and be mistaken for other conditions thereby escaping notification and investigation. There is always the danger that this form of the disease may revert to the acute form, or in young birds it may cause mortality preceded by nervous symptoms.

A warning of the possibility of a milder type of disease

existing unobserved was given by an experience in England in 1948. Some birds which had been sent to a Laying Trial from a hatchery gave positive reactions to the haemagglutination inhibition test. There was no history of illness among the birds at the trial and egg production was unaffected. Subsequent tests showed no evidence that reacting birds had transmitted infection to contact birds in the trial and this suggested that reactors had recovered before they entered. Other adult birds at the hatchery were tested and gave positive reactions although no illness had been observed in them. Enquiries indicated that for some time batches of young chicks on these premises often showed coryza at 2-4 weeks of age and a very mild form of Newcastle disease virus was recovered from some of them. It appeared that the newly hatched chicks were healthy but that they picked up infection in the brooder. They went through a stage of slight infection and then recovered with no observable subsequent effect. Suitable hygienic measures speedily eradicated the trouble.

This occurrence suggested that as well as the recognized more virulent form, a low form of Newcastle disease might exist in the country and that it might be fairly widespread. A survey was accordingly undertaken to ascertain whether birds at other hatcheries were similarly affected, but it failed to reveal any evidence of infection. It was therefore concluded that this low form of disease was not at all prevalent.

It was not until October 1950 that the problem of dealing with a less acute type of Newcastle disease assumed sudden and serious importance. No outbreak had been recorded in Great Britain for 5 weeks—when on 5th October disease was confirmed in Mildenhall, West Suffolk, and movements of poultry from this district through dealers and markets gave rise to many outbreaks in East Anglia. A feature in most of these outbreaks was the sub-acute nature of the disease; the most notable symptom being drop in egg yield, often accompanied by respiratory symptoms and greenish coloured droppings, but there was often little or no mortality. Failure on the part of poultry keepers to suspect the true nature of the sub-acute form of the disease, which was new to them, delayed the detection of outbreaks. Many came to light only in the course of tracing and it was frequently necessary to check the diagnosis by the haemagglutination inhibition test. By the end of 1950, 63 outbreaks of this form of the disease had been recorded in the eastern counties. Toward the end of December outbreaks of the sub-acute form appeared in other

parts of England and disease was found amongst birds which had been exhibited at the National Poultry Show. All birds from this show were traced, bringing many outbreaks to light, and during January 1951, 254 occurred in England and Wales, and 4 in Scotland.

The original source of this sub-acute form of the disease was not definitely ascertained but the first discovered cases were associated with swill from a U.S.A. Air Force Camp. The similarity in some respects of this form of disease with that commonly seen in U.S.A. gave colour to the view that infection came in that way, but the distribution of infection ascertained subsequently suggests that it may not have arisen from one source alone, and that it could have come from Europe masked by the more acute form, since both forms are known to occur in Europe.

Until the sub-acute form of disease appeared, movement restrictions applied to poultry had not included day-old chicks or hatching eggs—but since in the U.S.A. the sub-acute form of disease causes severe losses among young birds the term "poultry" was extended in subsequent movement Orders to include day-old chicks and hatching eggs. During the 1951 hatching season, however, only three outbreaks occurred in which young chicks were seriously affected.

The restrictions on movement and marketing of poultry which had been placed on East Anglia when this new problem appeared was at the end of December 1950 applied to the rest of England and Wales as a separate area, and when in February 1951 an increasing number of outbreaks of this form occurred in Scotland similar control restrictions were placed on Scotland.

Very wide publicity was given to the new aspect of this disease through the Press and B.B.C. The symptoms were described and precautions which poultry keepers could take to prevent the spread of disease were explained. Special attention was given to the disinfection of egg boxes at packing stations, and also of returned sacks used for foodstuffs. The problem had shifted from multiple invasion of recognizable disease to that of preventing spread before disease was detected. This publicity secured wide co-operation from poultry keepers, and outbreaks rapidly diminished from the January peak of 256 to 18 in April. Incidence remained low until a local epidemic commenced in October in Lancashire near Preston. These outbreaks occurred in a very heavily populated poultry district; and although the symptoms were mild in character the virus

exhibited a highly infectious quality. All movement of poultry out of the area involved was prohibited, but by the end of 1951, 225 outbreaks had occurred. However, the epidemic subsided by the end of January 1952 although the infection has not yet been entirely eliminated.

The total outbreaks recorded in 1951 was 844.

The importation of poultry carcases from any country in which Newcastle disease is endemic was finally prohibited by an Order which came into operation on 1st May 1951. This was a great step in aid of eradication although its effect could not operate fully until infected supplies already imported and held in cold store had been absorbed. In the meantime disease invaded other countries which were previously free, and these countries, viz., Holland and Canada were added to the prohibited list with effect from 12th November, 1951. So long as infected imports can be excluded the problem is confined to the elimination of infection already in the country.

In spite of the added difficulty of early recognition which the sub-acute form of the disease has introduced, a very considerable measure of success has been obtained in reducing infection. Such survey as it has been possible to carry out suggests that infection is not prevalent or generally widespread, and that many parts of England as well as of Wales and Scotland are probably free from infection. The progressive easing of restrictions on movement will give further indication of the true position, and it seems reasonable to hope that continued vigilence and energetic action against known disease will lead to final elimination.

On the question of slaughter versus vaccination I think we should first consider the aim to be achieved. If we intend to eradicate the disease that cannot be achieved by vaccination: stamping out by slaughter is a practicable proposition so long as certain essential factors can be secured. The channel of infection must be controlled and reduced to narrow limits. Outbreaks must be promptly recognized and quickly dealt with to prevent them multiplying beyond our ability to carry out rapid slaughter. The cost of slaughter over a period must in the long run bear economic relationship to the benefit it confers.

In applying this policy against Newcastle disease from 1947 to 1951 we have slaughtered 786,107 birds at a cost in compensation of £841,298. The average annual slaughter and compensation during these five years amounts to 157,221 birds and £168,259. Our poultry population in June 1951 was over

76 million and the number of birds slaughtered annually amounted to about 0.2 per cent. If final eradication can soon be achieved the price paid for freedom will be cheap having regard to the value of the industry and the heavy burden which this disease can impose annually should it become endemic.

Vaccination is a valuable means of reducing loss where the disease is endemic and causes heavy mortality and fall in production. But so long as the disease is not endemic and eradication is the aim the use of vaccine is contra indicated. Even if the vaccine used is incapable of setting up disease it introduces a handicap to successful stamping out by its effect of masking the disease. Partially protected birds can pick up and harbour infection and pass it to unprotected birds. This leads to the disease becoming endemic.

There are many problems concerning the choice of production of a satisfactory vaccine. Dead vaccines do not give a satisfactory immunity against Newcastle disease and live ones must be carefully adjusted in virulence as compared with the form taken by the natural disease. Also there must be reasonable certainty that the vaccine strain will not become more virulent in use.

If the disease were to become endemic in this country and eradication had to be abandoned, vaccination with all its problems would have to be seriously considered. The wide and effective use of vaccines would add a heavy expense to poultry production and would probably have to be continued for many years.

NEWCASTLE DISEASE*

NORMAN DOBSON

Ministry of Agriculture, Veterinary Laboratory, New Haw, Weybridge, Surrey, England

Kraneveld reported to his colleague Picard in 1926 that he believed it was a new disease of poultry, showing marked respiratory symptoms which was causing colossal losses in

---

* Paper delivered at the Fifth Annual Meeting of the United Kingdom Branch of the World's Poultry Science Association, London, England, Mar. 21, 1952.

the Dutch East Indies. The Civil Veterinary Department reported more than 2,000,000 birds as having died in one year. The disease spread rapidly causing a mortality of usually 100 per cent. Rodier made a similar report from Manila in the Philippine Islands stating the disease was spreading rapidly over the country.

In the same year, Doyle investigated an outbreak of disease at Newcastle-on-Tyne where all the birds on the farm died. He made an exhaustive investigation into the condition, recovered a virus, and tentatively named the infection Newcastle disease. In the following year, further outbreaks occurred in the more southernly counties of England, mainly Staffordshire and Somerset, causing the loss of all the birds on the individual farms.

Further reports followed quickly of this destructive disease of poultry, Edwards observed the disease in the Kumaon Hills, India, Cooper at Ranikhet, India, Crawford at Colombo, Ceylon, Konno, Ochi, and Nashimoto in Korea, Nakamura, Ovama, Fukosho and Tomonga in Korea and Japan. In 1930 Australia had its first invasion. By the interchange of tissues between many of these workers it was shown that one and the same virus was the causal agent of the widely separated outbreaks of disease, and despite minor differences, the diseases were immunologically identical.

Whilst every effort was made to trace the origin during the presence of the disease in England in 1926 and 1927, no source could be found. It is, however, important to note in the light of subsequent knowledge, that swill was being used on the farm in Newcastle, and this came from the collection of food refuse, including the docks, by the local authority.

In 1933, the disease was discovered in England in Hertfordshire, causing the loss of about 10,000 birds, but there was no spread of infection from the original outbreak. Again it was impossible to trace the source of the disease and no swill was being used.

From 1933 we believe the country was quite free from this disease until 1947.

In Australia the first outbreak of this disease was in 1930, the second in 1932 and the third in 1933.

Great Britain, Australia and South Africa are almost unique in so much that the disease has been present in the country and has been eradicated. Australia placed the whole of the State of Victoria in quarantine and closed markets, etc., on the occasion of the first diagnosis and on the subsequent entries. Most of the infected flocks were within 20 miles of

Melbourne, or coastal areas. These quarantine and stand-still measures were a powerful factor in the eradication of the disease.

When the disease occurred in Britain in 1926 and 1933 no measures were available to impose restrictions and pay compensation, such as were ready in 1947.

We have traced the spread of the disease in the East from 1926-1933 and then find other countries with centres of infection. Hudson reported its presence in Kenya 1935, and the C.V.O. Palestine in 1940.

The war period appears to have stepped up the pace of the transference of the disease to Greece, Jugo-Slavia, Italy, Egypt, the Northern coast of Africa, Spain, Germany, Russia, Poland, Czechoslovakia, Hungary, Holland, Belgium, France, South Africa, Canada and some Scandinavian countries. Our country alone was free until 1947.

During this long period nothing has been heard of the absence or presence of the disease in the United States of America.

From the literature one knew that a new disease had been found in California about 1931 and named Avian Pneumoencephalitis, which affected fowls of all ages. In the chicks, respiratory symptoms, nervous derangement and variable mortality occurred. In the adult fowls a sudden and complete loss of egg production occurred, drop in food consumption, respiratory symptoms, and finally slow return to lay in 6-8 weeks, when soft-shelled or misshapen eggs were noted. This disease continued to spread across the continent and frequent references to it were made in the scientific literature.

In 1946 Dr. Sims, Chief of the Bureau of Animal Industry, stated a virus had been isolated which was immunologically identical with the virus of Newcastle disease. The disease in the United States of America had in the main showed a very different clinical picture from that of the Asiatic type which had invaded so many countries.

When Doyle originally recovered the virus he carried out a large amount of experimental work which supplied much valuable information. He showed the virus is present in many of the tissues, (including the skin) and fluids of the naturally infected fowls. Asplin, 1948, showed the virus remained in a viable state for a long period in carcases under the conditions of cold storage.

Therefore the possibility of the importation into this country of the virus in frozen carcases, eviscerated or otherwise, was fully realized.

In 1926 the only means of differentiating the viruses of Newcastle disease and fowl plague was by means of the use of pigeons, which are susceptible by inoculation to Newcastle disease but resistant to fowl plague.

During the present epizootic we have had the advantage of a laboratory technique, known as the the H.I. test. By this means one can detect the antibodies in the blood of a fowl, after it has been infected usually a period of six to ten days.

The introduction of Newcastle disease in 1947 into this country was due to the importation of poultry carcases which were carrying the virus. The offal from these carcases was being sent unsterilized to poultry farms.

The Ministry decided a sampling of the consignments of carcases on arrival in this country, should be made in order that the consignments containing infected carcases might be dealt with specially.

Tissues were collected, prepared and tested in poultry or embryonated eggs, with the following results:

Young fowls	69%	infected
Hens	66%	"
Old cocks	80%	"
Geese	6.9%	"
Ducks	11%	"
Turkeys	24%	"

The sampling of the consignments was made by random selection of the crates, skin tissues collected from most of the birds in the individual crates and bulked as one sample. Inoculation of the material into two fowls, in the positive samples, caused symptoms, death of the fowls, typical post-mortem findings of the Asiatic type of the disease and the virus could be isolated.

VACCINATION AGAINST NEWCASTLE DISEASE

When a new disease has been discovered and the causal agent (virus or bacteria) found, there is a natural urge to discover a vaccine or agent which will immunize the susceptible animals and thus help in the prevention of the spread of infection. With Newcastle disease this endeavor has been long continued. In the early years following the recovery of the virus many of the older methods of producing a vaccine were employed.

Physical agents, drying and storage of the virus, etc., in an attempt to weaken the virus or treatment of the virus with chemical agents which would attenuate or kill it. The

results of the experiments using a large variety of agents are recorded. In some reports the trials appeared to give promise, many failed completely and at the best when the virus was killed, any immunity produced was of a very fleeting nature.

At this stage of our knowledge of the virus of Newcastle disease when I had been working with fowl passaged virus I became interested in the possibilities of using the technique of inoculating the virus into embryonated eggs.

Burnet and Ferrey had shown that Newcastle disease virus is highly infective for the developing embryo. They reported that the virus, after having undergone at least 12 passages through eggs during a period of three months was found to be fully virulent for fowls. In 1938 I commenced to passage the virus in eggs in order to explore the possibility that it may be rendered more suitable for the preparation of a vaccine. The Hertfordshire strain of the virus was used. At this stage Iyer, an Indian veterinarian, came to the Laboratory to study poultry diseases investigation techniques. The virus was used in several lines and was attenuated in from 14 to 33 serial passages in embryonated eggs.

Some work was carried out and eventually it was shown that this attenuated strain remained stable and under our experimental conditions gave good results as an immunizing agent, which immunity probably persists for life.

A vaccine prepared in this manner and used in India, Palestine and elsewhere in very large numbers of birds has according to the veterinary authorities of these countries proved helpful in saving the poultry stocks of their countries from destruction.

The Hertfordshire virus is a strain of considerable virulence, but it is not suggested that every strain of the virus could be attenuated.

Again using the Hertfordshire strain, experiments were carried out after a variable number of passages in embryonated eggs and treating the dead embryos with crystal violet. The results were not consistently satisfactory and the then war conditions necessitated the termination of the work. From this stage of vaccine preparation we passed to the use of strains of naturally low virulence as found extensively in the United States of America and also in Great Britain and elsewhere. These naturally low virulence strains are now being used following cultivation in embryonated eggs, as a vaccine inoculated into birds by various routes. These are the present types being used in America.

Doyle has more recently reported his work on an inactivated tissue vaccine prepared from finely minced chick embryos suspended in crystal violet ethylene glycol. Immunity after vaccination is established in about seven days and persists at least twelve months. It can be used safely on chicks from six weeks of age. The vaccine does not cause any reaction, paralysis or check in growth and the vaccinated fowls are incapable of transmitting infection to susceptbile contact fowls and does not induce a positive H.I. reaction.

During 1950 a small vaccination trial was carried out with a live virus vaccine at the Laboratory. The strain used had been isolated from a mild natural outbreak in this country. The results of the early experiments warranted a trial on a larger scale. The primary objects of the experiment were to determine the safety of the strain and to assess the duration of the immunity conferred.

VACCINATION OF YOUNG CHICKENS

About eight hundred two days old chicks were vaccinated by the intranasal instillation of one drop of allantoic fluid from embryonated eggs inoculated with this mild virus. Mild respiratory symptoms, particularly sneezing were present on the fifth day and had disappeared by the eleventh day after vaccination. The chicks remained bright and active and food consumption and growth were normal. There was no mortality attributable to the virus vaccination. Groups of chicks have been tested at monthly intervals for resistance to virulent virus. No chicks have shown symptoms after challenge although some have excreted virus.

VACCINATION OF ADULT FOWLS

More than two thousand fowls were vaccinated intranasally or were in direct contact with, or close proximity to, vaccinated fowls. The vaccine produced a mild reaction in a variable proportion of inoculated fowls. There was no mortality attributable to vaccination and with the possible exception of one farm where another intercurrent respiratory disease was present there was no observable decline in egg production attributable to vaccination. Fowls have been tested for resistance at monthly intervals and no symptoms have been seen.

NEWCASTLE DISEASE VACCINATION IN THE UNITED STATES OF AMERICA

Following the diagnosis of Newcastle disease it was re-

alized that a slaughter policy was impracticable, because of the widespread nature of the infection in so many States. Vaccination was therefore the only policy which could be followed. This has naturally stimulated the interest of scientific workers in the problems of vaccines and vaccination.

Living vaccines prepared from a variety of the mild strains are mainly used.

The vaccines are applied in several ways.

1. Intranasally by the instillation of a drop of the vaccine into the external nasal orifice.

2. Wing-web-stab method, by means of a needle coated with vaccine is passed through the web of the wing.

3. A drop of the vaccine placed in contact with the eye.

4. Spraying the vaccine over the heads of the young birds.

In some hatcheries vaccination by the intranasal route is carried out before the chicks leave the hatchery.

A prevalent method and stated to be very effective, is to vaccinate the adult stock by the wing-web-stab method just before they come into production. This may cause a disturbance when production commences. If carried out in laying birds there is a marked drop in egg yield over a period and it is stated that full production may not be reached. Vaccination of the birds just before production renders them immune for some months and gives a degree of immunity through the eggs to the chicks. Such chicks do not require to be vaccinated as day-olds, but are usually vaccinated by the intranasal route when the chicks are about four weeks of age which renders them immune until they are ready for killing as broilers or reach the laying stage. This double system of vaccination is stated to give good results.

The actual vaccination is carried out by "gangs" who tour the countryside. Usually about six women form a gang. They supply the vaccine and receive about three dollars per 1,000 birds. Losses in the chicks following vaccination are stated to be about 5 per cent and in unvaccinated groups the losses may reach 80 per cent.

Many commercial laboratories are producing the vaccines which are of three types, live virus (wing-web), live virus (intranasal) and killed virus. Newcastle disease vaccine production is not controlled as are the other biological products. However, the Federal Government issues licenses for vaccine preparation to laboratories in a State which is distributing the vaccine to other States.

NEW THEORIES ON METHODS OF SELECTION AND MATING IN POULTRY*

R. GEORGE JAAP
Ohio State University, Columbus, O., U.S.A.

I was probably optimistic in giving this address the title "New Theories" because I am reminded of that old saying "There is nothing new under the sun." A more appropriate title might have been "Modern Theories" or "Modern attitudes regarding methods of Selection and Mating in Poultry."

Poultry breeding consists of these two very important parts: (1) Selection of which males and females shall be used for parents and (2) How these will be mated once the decision has been made. To me the accuracy with which the parents are selected is most vital but we must not overlook mating methods because the two aspects of successful poultry breeding are, to some extent, dependent upon each other.

Most of our modern or newer theories regarding animal breeding arise from a change in concept. The new theories are dependent upon the breeder thinking in terms of the flock as a whole rather than upon the individuals within the flock. More specifically, it involves the concept of a population of genes rather than a number of isolated cases of contrasting characters. These genes are bundled together in little packets which are the individual birds. The grouping in packets can be broken and their contents re-shuffled each generation. This is just one of the mechanics of population or flock genetics. The birds are the units with which we select a population of genes which will produce the flock in the next generation. Selection of those to-be parents must be viewed from the aspect of how they may be expected to change the performance of the flock as a whole. Since practically none of the genes reseponsible for changes in economic value can be individually identified, population genetics involves an abstract thinking or reasoning which many people find difficulty in acquiring.

Thus even when we think of a specific gene, it is considered not only from the standpoint of dominance or recessiveness but also how frequent is it in the flock. A dominant gene may be very infrequent in the flock and have less influence than a frequent recessive one. Contrary to what many people think, dominant genes do not become more numerous; Nor do

*Paper delivered at the Fifth Annual Meeting of the United Kingdom Branch of the World's Poultry Science Association, London, England, Mar. 21, 1952.

recessive genes become less frequent unless some accurate selection is made for or against them. New terms have arisen as "gene frequency" or "gene drift per generation." Gene frequency may vary from 0 to 100%; However, most genes affecting something like egg production probably vary in flocks from say 30 to 70% or much nearer 50%. Even things which are highly heritable (that is, those in which the effects produced by the genes are more easily recognized) and due to a single gene seldom reach either the 0 (if unwanted) or the 100% (if wanted).

A favourite question I have for students is worded something like this: "A flock is carrying a simple recessive gene. What proportion of the flock would you expect to show the characteristic?" The answer usually is ¼ or 25% of the birds. Such a situation rarely, if ever, occurs in a flock. In fact if a hereditary characteristic occurs in 25% of the individuals of a flock it is almost positive proof that it is not a simple inherited recessive. To appear in 25% of the progeny, 50% of the genes in the flock must be of the recessive type and 50% of the dominant allele. This seldom, if ever, occurs in practice. Crossbreds, involving a simple difference as rose and single comb or White x Yellow skin, and their progeny without any culling or differential mortality would be the only type of parent flock which would give 25% single combs or 25% yellow legs.

An example of a low gene frequency of a highly heritable characteristic is the frequency of the gene for yellow legs or skin in Light Sussex flocks. This has probably increased in recent years due to the occasional person mistaking a Rhode x Sussex crossbred for a purebred Sussex. Just to illustrate this let us consider that we have a flock in which one bird in 500 carries a recessive gene (one gene every 1,000) for yellow skin color. A person could breed such a flock for years without ever seeing a yellow legged chicken. In fact a yellow-legged chicken would be expected only once in every million chicks hatched.

Some genes appear to give an advantage to the stock. I believe this must be true for single comb in breeds like Wyandottes. Most stocks in our country continue to produce 8 to 12% single comb chicks. It can be readily shown that by culling the single combs, the flock should produce, after 10 years of breeding from only rose combs, about 1 single comb chick in every 100. The only way such a high percentage (8 to 12%) of single combs can persist in Wyandottes is that the *Rr*

individuals are more apt to be retained as breeders than the *RR* ones. To attain this percentage of single combs approximately 40% of the genes would be *r* or 60% of the flock *Rr* (hybrids?). I have purposely chosen Rose and Single Comb because its inheritance is well known. However, when we consider flocks, its flock genetics is at present a mystery. In other words, we know a lot about Rose and Single comb in an individual or in individuals but we know practically nothing about their behaviour in a flock from year to year. Fortunately yellow legs in Sussex appears to behave more normally and may be predictable in flocks from year to year.

SELECTION OF PROSPECTIVE PARENTS

1. *What yardsticks or measures shall we use?* Each must be easily obtained with a minimum of labor per bird. Poultry breeders spend too much time collecting cumbersome and useless records. If these measures are worthwhile, they must accurately reflect the value (or loss).

New refinements and short cuts are constantly being developed. Using egg production, for example, everyone would say the measure is simple; How many eggs were laid? But the question arises, "In how long a period?" The old idea was 365 days from first egg. New ideas are to 500 days from hatching, 300 days from first egg, etc. The main purpose of these is an economical one, to free the house for the next crop or to avoid overlapping of costly record keeping. Even with these shortenings of the period for economy purposes 2 years are involved for each generation. It is not surprising then that there are proponents of short term records to allow raising a new generation each year. It can be shown that more progress is possible due to halving the generation interval. Thus autumn and early winter records of egg production, if they are the measuring stick have more value than half of the whole year's record and allow using the pullets to reproduce the next generation.

In addition to the length of period covered, there is also the question of time used in trapnesting. Twice as many hens can be measured if they are trapnested only 3 days per week. If selection of the individual is largely upon its family's performance the accuracy of selection is almost as great as if trapnests were used every day in the year. There are just as many proponents of each system as there are research workers. The breeder must weigh the evidence and make his decision.

Something few theorists realize is that chickens, unfor-

tunately are still sold on the number of eggs their dam laid in 365 days. Thus when 300 day alternate was permitted for our R.O.P. a 200 egg hen became a 180 egg hen or a 60% production dam for sales purposes.

This brings up the second point I wished to make in selection of prospective breeders, namely;

2. *How much economic value has one unit of difference in each measure used?* Efficiency of breeder selection depends on weighing one trait against another. Of all traits which have economic value as ability to live, egg numbers, egg size, fertility, hatchability, body size, freedom from defects and uniformity, interior egg quality, etc; the amount of emphasis is partially determined by the sale value. These may differ for each breeder or stock he has. One relatively minor defect can ruin a breeder's sales. To him it is of major economic importance.

3. The third point involves the conception of a *selection differential* and how much of the difference between selected parents and their culled flock mates is due to heredity and how much is environmental. We have to devise methods for detecting differences in genetic make-up rather than chance superiority due to feeding, management and lack of disease contact. When it is possible we must allow for environmental differences to make accuracy of selection better. Let me give one illustration of this in the selection for rapid early growth in table poultry. It is known that no two hatches of chicks grow at exactly the same rate. A measuring device for growth which allows for these environmental effects may be accomplished simply as follows: At the appropriate age, which in U.S.A. is 9 to 10 weeks, males and females are sorted and counted into separate weighed coops. The average male and the average female weight is thus calculated. As each chicken's weight is obtained it is not recorded in pounds or ounces but how many tenths of a pound or ounces it is over or under the average for its sex in that brood as +3, or —5, etc. If it is necessary to reduce the numbers of birds, judicious use of a culling level may be made directly. For example, all those below average may be culled, or in males all those which are not +5 or more above the average.

This concept of a selection differential and allowing for vagaries of environment is very important. When anyone asks me how many eggs a hen should lay to be selected for a breeder my answer is "at least 30 to 40 eggs higher than the average of the flock and from a family of sisters well above

the flock average." Wherever possible in breeding, it is best to let the average of the flock be the measuring stick and select for values well above it. In the future we may expect many more new and novel devices of estimating how much of the difference between selected parents and culled sibs is due to heredity. When the environmental part of the difference is large it does not necessarily mean that we can provide a good environment and thereby decrease the environmental effect. It does mean, however, that devices will be contrived to allow for environmental fluctuation as between years, hatches, etc., and thus make the accuracy of our selection much better.

4. *Genetic correlations* may exist and exploration of these has begun only recently. Does selection for one thing improve another or is it antagonistic, causing another trait to be poorer? Some examples of this are known. Selection for large egg size increases body size. Selection for large body size at first egg is antagonistic to early sexual maturity. A number of similar genetic correlations are known and more will be found.

It is possible that genetic correlations of the antagonistic type may cancel out to almost zero and make our selection useless. In contrast genetical correlations among desirable traits may simplify our selection. By recognizing this we can place emphasis on that one most readily measured.

5. The 5th point in selection of breeders involves the hope that in the future it may be possible to devise *selection indices.* For example, we might arrive at a numerical value or index for each hen which would rate the probable value of each hen as a breeder. Then we could merely select the hen with the highest rating. Those with plenty of optimism think that we should in the future have enough information to divide the number of eggs by some number; divide egg weight by another number and add it; divide hatchability by some other number and add that; divide body weight by still another number, etc. The construction of such an index depends on knowing the heritability and the relative economic value of each characteristic. Personally, I am pessimistic that indexes of breeding value will ever be constructed in a useable form for the poultry breeder. Others, however, are not nearly so pessimistic as I am. Actually the breeder does give more weight to things which have economic value. If any one doubts this all they have to do is count how many breeders in my country get a much higher price for chicks from high record dams. Their heritability of the dam's record is very very low, yet it has a high sale value. Many arbitrary scores are used by different breed-

ers. One breeder I know arbitrarily scores his selected breeders into 3 grades; A, B and C. To each of these he adds a superscript or two indicating the family weaknesses. For example an A^{sm} hen would be a good prospect with family weaknesses of small egg(s) and late maturity (m). In this way he avoids the same family weaknesses in both sire and dam.

The other points I wish to bring up in connection with selection of the parents for the next generation are closely interrelated with the mating methods and the specific type of selection of breeders most suited to each method.

Mating Method 1. The first mating method I wish to discuss is *flock mating*: that is matings involving 2 or more sires with no pedigree. I can hear you saying "Why there's nothing new about flock mating. People have been mating chickens in flocks ever since they were domesticated. Flock mating is not breeding, it is simply reproduction or multiplication." That may be true but there are several aspects of flock mating that flock genetics had made us sit up and notice. I, myself, have been guilty in the past of saying that if you bought a breeders stock and flock mated, it would go downhill. The question raised by recent theories is "Will it go down?" The total kinds of genes in a flock do not change just because it is flock mated. It would require a number of years before differential reproduction rates and mortality could affect it very much. Few people realize that inbred lines used for crossing to produce the hybrid chick are maintained by flock mating. Once a line has been brought up to the 50 or 60% coefficient of inbreeding, it may be flock mated from that time on, or until a new line may take its place.

Theoretically, a flock declines in productivity only so much as hybrid vigor (dominance, overdominance, and epistasis) is involved. This should not be great in one strain closed flocks. There is very little information available in the form of critical tests of this theory. One Rhode Island Red breeder I know in America stays uniformly high in the laying tests with entries from flock matings only.

Another new aspect of flock mating is that it is the best method of breeding for highly heritable characteristics like egg weight, body size and growth rate. Strains of chickens which grow most rapidly, have largest egg weight, most uniform egg colour and shell texture, and (believe it or not) the highest hatchability in the U.S.A. were produced from flock matings; no pedigree and no family records. Flock genetics tells us that, theoretically, flock mating with a high selection

differential produces most rapid progress when heritability is high. The key to success of the flock mating for such characteristics is a high selection differential; that is, those selected for parents should be very high above the average of the flock from which they were selected.

Few poultry breeders realize the genetical implication of the "Closed flock." They get frightened that someone has better stock and instead of getting a good sample of this competitive stock and testing it for themselves, they try a rooster. This rooster's daughters do pretty well and, as a result, into the flock they go, upsetting the gene frequency, and changing the flock's inheritance probably for the worse rather than the better. Such breeders find themselves bringing in another rooster in a few years. Their flock thus becomes about average for the breed. Unless a person is starting, and plans to continue, a strain-crossing program he must stay within a closed flock to progress. If he locates a strain which on test will do better than his own, theory tells us he should switch to that strain and discard his own for most rapid progress. "Slipping in" a rooster from the other strain results in a breeder having neither his own strain nor the superior strain. In fact it will take him several years to find out that perhaps he might merely have gotten a little improvement from hybrid vigor which cannot be maintained in one intermated flock regardless of how close the pedigree and progeny are observed.

Pedigree breeding and its accompanying tools of sib-testing and progeny testing still remain the best selecting and mating mechanisms yet devised for a one-strain purebred flock when egg production, ability to live in the laying house, and similar characteristics of low heritable nature are involved. These are only measurable in the females and sire testing is the only method of selection possible for egg production in a male.

Since the sires represent in number only 1/15th to 1/20th of the flock, yet carry the inheritance of at least half the flock, it is not surprising that recent theories have given stress to the importance of sire testing. Dr. Hagedoorn has done much in this country to stress how much may be accomplished by merely testing of sire families. Theoretically there are two very weak points in the "Hagedoorn Nucleus plan." First; if the parents are "bottle-necked" down to the one best sire-family each year, the available inheritance for improvement in a few generations will become too limited. Second; evidence of recent years is strongly against the pos-

sibility of attaining a superior highly inbred line. Sooner or later all closely inbred lines must decline in productivity if our present theories are correct. The Hagedoorn nucleus plan if followed to the extreme inbreeds too highly for a superior closed flock performance.

MATINGS DESIGNED TO UTILIZE HETEROSIS

It is now becoming increasingly apparent that by appropriate mating methods it is possible to make the progeny slightly better than their parents for characteristics like egg production, rate of growth and ability to live during the early growing period. Further than this, it seems possible to produce stock which will lay slightly better or grow slightly better than the best closed flock strains. This phenomenon of heterosis is elusive but definitely present for the characteristics I have mentioned. Thus the newest selection and mating methods are those now being devised to best utilize heterosis as well as straight-forward "additive" inheritance. This year, 1952, is at the beginning of the hybrid vigor era which appears to be rapidly being unravelled from its maze of obscurity. All research workers agree that the amount of increase from heterosis in production, growth rate or ability to live during the growing period is small for poultry and probably will never approach the 20% improvement acknowledged for the better hybrid maize-crosses. However, if the improvement possible by hybrid vigor in poultry is as much as a 5% increase it is well worthwhile to use mating methods designed to take advantage of hybrid vigor without losing sight of inheritance in which hybrid vigor does not exist.

Matings which are designed to use hybrid vigor are:

1. Strain or breed crosses, including progeny testing of the cross.
2. Reciprocal recurrent selection between two closed flock breeds.
3. Recurrent selection of a closed flock against an inbred line.
4. Close inbreeding and crossing of those highly inbred lines.

I believe that the best way to describe the way modern theory is pointing is to briefly and sketchily outline some points on the procedure of selection and mating for each method. In this way it might be possible to indicate where some common practices may be at fault. (Note that I said "Where some present practices *may be* at fault.") Many of these mating systems which I plan to discuss are still largely

in the theoretical stage and will require actual testing to determine their value for the poultry industry.

CROSSBREEDING OF CLOSED FLOCK BREED STRAINS

The first step is to find out which breed strains produce the best crossbred. In the first place all breeder's flocks which have not been closed should not be considered. How long they should have been closed is a difficult question. My personal estimate is 15 to 20 years. One reason for the closed flock is that your purpose is to sample that closed flock and, if you like the sample, to be able to go back a year or so later and get exactly the same flock inheritance. Another reason is that you want the different strains used for testing to have no common ancestry for many generations. In some ways the chances for obtaining hybrid vigor are greater in non-related stocks. This is theoretically explained by differences in gene frequencies.

The choice of actual breeds to select is dependent on several factors. One of these is that each breed or strain be an excellent layer in its own right. Thus far I have never seen any evidence that a mediocre or poor laying non-inbred strain will ever produce a superior crossbred for egg production. In the U.S.A. this narrows the field down to the S.C.W. Leghorn and the Rhode Island Red with a possibility of sporadic strains of New Hampshires, Barred P. Rocks, and even White P. Rocks. In Australia it would be Australorps and White Leghorns. In the British Isles it would be Rhode Island Reds for one, but where to go from there is another question; possibly Brown Leghorns, and Light Sussex. This brings up the second point.

2. Considerable time can be saved by utilizing existing information in the selection of breed strains. Which breed crosses and which strains of which breeds are producing the best egg production crosses? Popularity, does not necessarily indicate the best breed crosses but may indicate strains. For example, the W. Leghorn x R.I.R. has never been popular as a breed cross but are the parents of the most successful crosses of inbred lines in the U.S.A. To me this indicates the selling power of a trade slogan which, in this case, is "crosses of inbred lines."

3. Where there is any indecision over a heavy x heavy and a light x heavy breed cross, I should personally favour the the light x heavy cross. My basis for this is two fold. First, it is more likely to be a more distant (less genes in common frequency); and Second, limited evidence in America shows that the W.L. x heavy breed, in general, seems to edge out in

superiority; especially in the large-pen confined method with layers in our climate.

4. To select the strain of each breed make tests from flock matings involving at least 5 to 10 sires. Random samples of over 50 cross-bred pullets of each cross being tested are best. These should be reared and housed in different locations, preferably some of each test cross in each location. If a wide type of management is being bred for, then they should be duplicated in folds, in batteries and intensively. All possible commercial crosses should be tested, that is, both ways (reciprocal) if commercially adaptable. From these tests of at least 3 or 4 strains of each breed in all possible combinations, the two strains which produce the best cross are chosen. Repetition of the test for a second or third year would be preferable but we are always impatient to get started.

The importance of these tests cannot be over-emphasized because, theoretically, it might save many years of breeding if one should arbitrarily make a poor choice for the start of the breeding project. Flock geneticists tell us that progress is slow in increasing the combining ability of crossbreds if they happen to have similar gene frequencies. Therefore, we should thoroughly explore existing strains to pick those two which are already at the point of most suitable divergence. Otherwise we are not making the most of available breeding material.

5. The next step is to family test not as purebreds but as cross-breds. There are several ways for these crossbred progeny family tests. However, it is imperative, both theoretically and practically, to test the crossbreds rather than the purebreds.

The simplest test might be illustrated by taking an example of where the commercial chick is going to be out of Brown Leghorn sires and Light Sussex dams. The first step with these is to place Sussex pullets at random into the breeding pens. Each breeding pen of females should be a sample of the chosen Sussex strain. Brown Leghorn males of the selected strain are used on these pens and from each pen enough crossbred chicks are reared to be able to house at least 50 laying pullets from each sire. It is important that there be many breeding pens, not less than 20, and 50 to 100 would be much better. From the performance of these sire-families of crossbred pullets several of the best sires are chosen. It is best to have selected at least 4 or 5 sires. These sires are then used to produce the next generation of Brown

Leghorn males. If these Brown Leghorn males were pedigreed it would be advantageous to use only their sisters but avoid mating more than possibly a sister or two with each male, the rest of the females being sisters of the other males or use a flock mating. It is important to keep inbreeding low. That was my reason for saying at least 4 or 5 of the best sires should be selected to reproduce the Brown Leghorn male line. With five sires the coefficient of inbreeding would increase only to 3 per cent per generation. Most poultry geneticists will agree that this rate of inbreeding is not too great.

Now you ask which Sussex individuals are used to produce the next generation of Sussex. Since they are the female or dam side of the cross, they must be kept very prolific. They could be family-tested or progeny tested as pure Sussex. According to our present theories which as yet are untested, family-testing of this Sussex dam line is not the best selection and method. This brings up the 2nd and might I say the most popular theoretical breeding method at the present time.

Breeding Method 2. It is called *Reciprocal Recurrent Selection.* Before I outline some sketchy details on this method of selection and mating, I wish to stress that there are, as yet, practically no tests of its suitability. It is the dream child of mathematicians to make the best approach to utilizing both inheritance which gives rise to hybrid vigor and inheritance which gives results in closed strains. To me it is the ultimate in crossbred progeny selection involving a cumbersome set-up which may or may not prove to be worthwhile.

The first steps are identical to those I have just given for crossbreeding. The strain of each breed is decided by flock sample crossbred progeny tests which are very important. Then half of the breeding pens contain random samples of Brown Leghorn females and the other half Light Sussex females. Sussex males are crossed with Leghorn females and Leghorn males with Sussex females. From their progenies the best mothers and fathers of crossbreds for each breed are selected. Selecting no less than 4 or 5 males and 60 to 100 females of each breed from the performance of their crossbred progeny, both breeds are reproduced by *flock mating.*

Flock mating to reproduce the pure breeds from the crossbred-progeny selected parents is very important because your aim is to re-shuffle the genes around and avoid their fixation into different lines within each breed strain. From these purebred progeny of the flock production, selected females and males are again randomized in the pedigree pens

for the second reciprocal test. And the whole procedure is repeated. First a crossbred test; then a flock reproduction of the selected purebreds; followed by another cross-bred test and flock purebred reproduction, etc.

There are many modifications and some short-cuts to this tedious procedure. Each breeder's situation is a different one. One breeder I know, using this recurrent reciprocal mating and selection method, planned to reproduce his purebred generation by having 15 females of the same breed as the male and get his cross tests from 5 of the other breed in each pedigree pen. He planned to test 100 sires by using two shifts of males in his 50 pedigree pens. In this way he would be producing his purebred cycle at the same time as his crossbred one. Using a short term egg production test on the crossbreds, he could complete one cycle each year. This has two big difficulties. First is to get enough purebred progeny from the selected sires for the next crossbred cycle and second, the large number of progeny reared from rejected sires.

It must be readily evident to all that there are many stages of testing complexity. The simplest is crossbred-progeny sire-testing without trapnests in only one direction. The most complex is complete reciprocal recurrent progeny testing. The crossbred chick producer cannot wait until tests determine which procedure is most effective, considering financial expenditure. His decision rests on whether the small advantage of hybrid vigor is worthwhile. If he decides it is worthwhile then he must choose what rung on this ladder of crossbred progress he is going to reach. Theoretically, the rungs of this ladder are further apart at the bottom and nearer together at the top. The first stages might be expected to bring more progress for each step taken.

METHODS INVOLVING USE OF HIGHLY INBRED LINES

Breeding Method 3. *Recurrent selection to an inbred tester* line which is to be used as one parent of the commercial chick.

The previous method of reciprocal recurrent selection of non—or slightly—inbred lines may be likened to fitting many keys into many locks. Recurrent selection to an inbred tester line might be likened to fitting one key into many locks. Theoretically the inbred line should be one of many generations of bro x sis or parent-offspring matings. It is the fixed key. In poultry such a line may be difficult to maintain in good reproductive state and would probably be utilized as the sire of the resultant commercial cross.

The selection and mating method is simply to progeny test against this inbred line which is maintained as a flock mating without any selection other than a reduction to the number needed. One procedure at the start is to test as many different strains as possible with this inbred tester. These should be tested in several locations and probably two or three years. Another procedure would be to start with a heterogenous group of males and females, proven by crossing with the inbred line. As an example with an inbred Leghorn tester, the other breed, say Rhode Island Red, is tested only by the performance of its crossbred progeny with the tester. The best Rhode parents of crossbreds are mated together to produce the next generation of Rhode Island Reds. These are again tested against the tester, reproduced, tested again, etc. It sounds simple, doesn't it?

Theoretically you do not have to worry much about what inbred line you choose as long as it has a very high coefficient of inbreeding. This aids in keeping it genetically the same each year. It would be well to have as good reproduction as possible in this inbred line because it is always one parent of the commercial baby chick.

All three of these breeding methods I have outlined thus far, have an advantage that good commercial chicks are being produced each generation. Since most poultry breeders must exist from the sale of chicks these matings have a decided advantage of an income from the project. The development of the inbred line involves wastage and economic loss. A number of experiment stations in the U.S.A. are developing inbred lines. In the North Central region where Ohio is located there are over 60 inbred lines with various coefficients of inbreeding from 25 to 90 per cent.

The 4th and last selection and breeding method involves the development of so many inbred lines that there is certain to be a large financial loss before sale of commercial chicks are possible.

Breeding Method 4. *Crossing of Highly Inbred Lines.* This method follows the hybrid maize pattern in so far as possible. It has been underway and popular in some of the so-called corn (or maize) belt states of the U.S.A. They are being sold in this country this season. It involves the development of a large number of inbred lines. With us, inbred lines of poultry are considered to be those that have coefficients of inbreeding of more than 50%, or equivalent to more than 3 generations of brother x sister mating. In the early 1940's White Leghorn and Rhode Island Reds of the highest produc-

tion strains were chosen for inbreeding. Strains of these two breeds are leaders in egg production in the U.S.A. More recenlty high production strains of other popular breeds are being used. After the production of a large number of inbred lines of Leghorns and Rhodes, there follows a testing period of crosses among them. Since the inbred lines have been inferior egg producers, the 4-way cross of the hybrid maize fame has been utilized. In a few cases a 3-way cross is used. The pattern of the 4-way cross I believe must be familiar. It is something like this.

Inbred W.L. x Inbred W.L.		Inbred RIR x Inbred RIR	
No. C	No. S	No. 7	No. 1
Incross W.L.		Incross RIR	
No. CS		No. 71	

Incrossbred No. CS71

The three way cross utilizes an inbred sire instead of the Incross (CS) of the diagram.

In the U.S.A. they are only popular in some states. In my home state of Ohio about 5% of the baby chicks sold last year were of this hybrid incrossbred type. Production comparisons are difficult to obtain but most tests, including the one we are making at Ohio, show a slight superiority for these so-called "Hybrid Chicks" over commercially produced crossbreds and purebreds. This breeding method involves the greatest capital expense due to the long breeding and testing period during which no chicks are sold. Whether "hybrids" would have enjoyed the excellent high-priced sales without the hybrid maize predecessor is an unanswerable question. It will be interesting to follow what happens here in so far as popularity of the New "hybrid chick" is concerned.

UNITED KINGDOM BRANCH OF THE WORLD'S POULTRY SCIENCE ASSOCIATION

The Fifth Annual General Meeting was held in London on Friday, Mar. 21, 1952. Eighty-one members were present. Papers were presented by Dr. R. George Jaap, Mr. E. C. Lloyd and Mr. N. Dobson.

Membership to the United Kingdom Branch now totals 332. The officers are Dr. R. Coles, President; Dr. R. F. Gordon, Vice-President, and Major Ian Macdougall, Secretary-Treasurer.

PULLET REARING AND EGG PRODUCTION ON HOME GROWN FOODS

R. B. SHAW and E. W. NIGHTALL

University of Nottingham, School of Agriculture, Sutton Bonington, Loughborough, England

The results of our first attempt at rearing chickens on home grown foods were published in March 1950,[1] followed by a report on egg production a year later.[2] The purpose of these experiments is to present evidence, mainly for the general farmer, on the extent to which successful rearing and egg production can be accomplished from the use of home grown feeding stuffs.

REARING

The experiment was repeated in 1950-51 with a larger number of chickens. The hatching date was April 28th and each of the three groups consisted of sixty-two pullets made up of 44 Rhode Island Red x Light Sussex and 18 Brown Leghorn x Light Sussex.

As no field was available on the general farm, the pullets were reared in pens of approximately 510 square yards. Although these pens were seeded down as long ago as 1923 the herbage appeared to be of good quality. The housing, method of brooding and management were similar to the previous occasion.

The day old pullets were divided into groups A, B, and C. The basic mash formula for groups A and B consisted of Ground Oats, steamed bone flour, manganesed common salt and cod liver oil. The B mash had added to it bean meal, but reduced in quantity by 50% compared with the mash used the previous year. Both these groups were given wheat as a grain feed. The group C mash contained more ingredients including fish meal and the grain consisted of wheat, barley, oats and maize.

The reduction in the proportion of bean meal in the B mash had some effect in that the chickens found the mash more palatable than in the first year and except for the first four weeks consumed more of it. This led to a desire to graze and a greater degree of contentment but did not seem to influence much the extent to which the average weight of the birds in the bean meal group was greater than the average weight of the birds in the no protein group at the age of 24 weeks.

The 1949 groups contained a much higher proportion of Light x heavy pullets therefore the average body weights in

the two years are not comparable but the 1949 figures have been included so that the relative weights of the three groups in the two years can be compared. (Table I)

TABLE I
Rearing Rations and Results

	Ration A No protein supplement	Ration B Vegetable protein supplement	Ration C Normal**
Mash			
Ground oats (lbs.)	28	21	
Steamed bone flour (oz.)	12	9-3/5	
Manganesed salt (oz).	2	3-1/5	
Cod liver oil (pt.)	1/8*	1/8*	
Bean meal (lbs.)	——	7	
Grain	Wheat[1]	Wheat[2]	
Food per bird for 24 wks. (lbs.)	27.91	28.51	30.43
Weight at 24 wks. (oz.)			
1950	71.81	74.42	80.86
1949	58.94	60.75	71.70
Rearing mortality (%)	14.5	16.1	9.7

* For first 8 weeks only
[1] One-half of total daily ration
[2] One-third of total daily ration
**(The mash contained varying amounts of fine offals, maize meal, ground oats, potato flakes, fish meal, barley meal, grass meal, dried yeast, dried milk, limestone flour, mineral mixtures and flint grit. The grain consisted of wheat, barley, oats and maize).

EGG PRODUCTION

Fifty pullets of each group, reared as already described were accommodated in slatted floor houses as on the first occasion. The A group was placed in the pen previously occupied by B, B in place of C, and C in place of A.

TABLE 2
Rations for Egg Production

	Ration A No protein	Ration B Vegetable protein	Ration C Animal protein
Mash*			
Ground oats (lbs.)	56	21	15
Bean meal (lbs.)	——	7	——
Ster. bone flour (lbs.)	2-1/2	1-1/4	——
Manganesed salt (oz.)	4	2	1
Dried grass (lbs.)	3	1-1/2	3
Cod liver oil (pt).	1/4	1/8	1/4
Fine offals (lbs.)	——	——	10
Coarse offals (lbs.)	——	——	3
Fish meal (lbs.)	——	——	3-1/2
Limestone flour (oz.)	——	——	15
Barley meal (lbs.)	——	——	9-1/2
Maize meal (lbs).	——	——	5
Grain**			
Wheat	1	1	1
Barley	1	1	1
Oats	——	1/2	1

* Mash was fed dry to all groups and was always available.
** 2 oz. per bird per day.
There was also a constant supply of cockle shell and flint grit.

The only change made in the feeding was a substantial reduction in the proportion of bean meal included in the mash for group B. Table 2. (In 1949-50 the mash contained 14 pounds of ground oats and 14 pounds of bean meal.)

The birds in Group C (animal protein) came into production earlier than the others and by December 9th had laid 1,296 eggs whereas Group A (no protein) had laid 338 and Group B (vegetable protein) 433. An improved contribution by Groups A and B to the autumn egg supply would probably have been forthcoming had it been possible to arrange an earlier hatching date. After December 9th the performance of all three groups was remarkably similar. Group B did rather better in January, February and March and Group A in April and May and again during the final period.

The results are substantially different from those of the previous year, the "vegetable protein" group on a much reduced proportion of bean meal showing a great improvement and producing a little better than the "no protein" group. Table 3. The "no protein" group averaged 15.5 eggs per bird less than the "animal protein" group in contrast to an advantage of 26 eggs per bird in experiment No. 1. Even so

TABLE 3
Results for 48 week laying period

	Ration A No protein	Ration B Vegetable protein	Ration C Animal protein
Ave. grain and mash per bird (lbs.)	108.29	110.42	107.78
Ave. production (eggs)			
Based on birds alive at end of each 4 week period	171.29	176.74	187.71
Based on number of birds housed	168.20	170.68	183.74
Final ave. wt. of birds	6 lb. 3 oz.	6 lb. 2 oz.	5 lb. 15 oz.
Mortality (%)	6	10	10
Egg Receipts	£147-3-6	£149-5-9	£163-19-1
Food cost	£56-6-1	£60-11-10	£65-14-3
Margin per bird over cost of food, shell and grit	£1-16-11	£1-16-5	£1-19-10

the hen housed average of 168.20 of Group A will probably be considered by many general farmers to be satisfactory and well worth having. Under free range conditions the "no protein" birds would perhaps show up better than when confined to a pen over which poultry had run for a number of years.

When this experiment was planned it was not the intention to work out the results on a cash basis and no reference was made to cash returns in the report on Experiment No. 1.

It is now felt that such information would not only be interesting but would make possible a more accurate interpretation of the results. This extra data has now been added.

The food consumption figures had been carefully recorded and it was not difficult to insert the costs. All the grain has been costed at market value. The home grown foods used in mashes A and B have been charged at market value but the individual foods in mash C, except the grass meal, were costed at merchants prices.

With regard to the cash returns for the eggs, the figures are not quite so accurate since the eggs from the experiment were not sold separately. As however, there appeared to be no difference in quality between the groups, and the number of eggs graded as seconds or rejected at the Packing Station was very low over all the eggs sent in from the Poultry Farm, it can be taken as reasonably accurate that the eggs from the different groups were of equal quality. The figures presented have been worked out on the assumption that all the eggs were of first quality.

The receipts from the "bean meal" group were only £2-2-3 greater than from the "no protein" group. The receipts from the "fish meal" group were £16-15-7 more than from the "no protein" group and £14-13-4 more than from the "bean meal" group.

When the food costs are deducted from the cash returns the differences between groups A and B and group C are greatly narrowed. The higher cost of feeding group C (Animal protein) has a marked effect on the margin of receipts over food costs. The amount in favour of group C over group A (no protein) is reduced to £7-7-5 and the amount in favour of group C over group B (bean meal) is reduced to £9-10-11. The "bean meal" group loses to the "no protein" group to the extent of £2-3-6.

These figures show that the lower cost of feeding home grown foods has a very definite influence on the profits from egg production. The inclusion of vegetable protein reduces the good influence of the home grown foods because of its high cost. It would seem from this experiment that any increased egg production got from the use of a normal ration containing fish meal is greatly offset by the higher cost of such food.

PREPARATION OF THE REPORT

Miss M. E. Lambert, N.D.P., has assisted in working out some of the figures connected with this report.

REFERENCES

1. R. B. Shaw and E. W. Nightall. Rearing chicks on home grown feeding stuffs. *World's Poultry Science Journal 6:* 201-206. 1950.
2. R. B. Shaw and E. W. Nightall. Egg production on home grown foods. *World's Poultry Science Journal 7:* 202-207. 1951.

CONTROL OF LICE AND MITES

FRED E. ALLEN

Veterinary Department, University of New Hampshire, Durham, N. H., U.S.A.

Most of our poultrymen have worked out a very good system of control in keeping lice and mites from their premises. However, the advent of a built up old litter has interfered with the sanitation program and occasionally we get a request for advice in order to eliminate lice and/or mites from such premises. In addition, these pests may occasionally get onto the premises of an individual who has successfully controlled them in the past.

Lice spend their entire life cycle on the bird and substances such as nicotine sulfate applied to the roosts or sodium fluoride dusted on the bird will very effectively control them. DDT dust applied to the body of the bird in a 4% concentration will likewise control lice and it has a residual effect which will take care of the eggs when they hatch.

Mites spend their time in cracks and crevices and only come to the bird for a meal of blood. Therefore the premises have to be treated to control them. Most poultrymen clean up between lots of birds and spray the floors, walls and dropping boards with carbolineum. With a built up old litter the carbolineum spray is eliminated and often times the mites begin to build up.

A recent discovery known as lindane (99% gamma isomer of benzene hexachloride) in a 1½ per cent solution sprayed on the roosts, dropping boards, walls and nests should control lice and mites. If a heavy mite infestation exists this may have to be increased to 2½% solution.

The Entomology Department at the University of New Hampshire has been studying miticides for the control of poultry mites. One such preparation, known as Aramite has given very satisfactory control under field conditions. It was applied to the premises including the litter. It was used at the rate of 1 pound of 15% wettable powder to 100 gallons of water or as a 3% dust. Apparently, it is relatively safe, both to the operator and to the birds.

SURFACE ACTIVE AGENTS AS GROWTH STIMULATORS IN CHICK RATIONS*

C. M. ELY and STUART SCHOTT
Research Division, National Distillers Products Corporation, Cincinnati, Ohio, U.S.A.

Several years ago, our Company considered various wetting agents for use as liquefying agents in the distillery grain cooking process. Predominant among those tested was a polyethylene oxide condensate ester of coconut fatty acids, termed "lauryl ethylene oxide condensate" or "LEOC" in this report.

Recognizing the fact that the wetting agent would become residual in the Distillers Solubles, toxicological chick tests were set up to determine its effect, if any, on the feeding value of the Solubles. In the course of these tests, a consistent growth improvement was noted in chicks fed very small quantities of LEOC. As a result of this early work, numerous experiments followed to evaluate the nutritional properties of this and other surface active agents.

Although many investigators have reported work which appears to be in certain ways related to this general concept, only two published references to directly similar experiments have come to the attention of the authors.

In two tests in which quaternary ammonium compounds were fed to chicks purposely infected with *Ascaridia galli*, Reidel, Barber and Hays[1] noted increased growth responses of 10.0 and 14.9 percent over non-supplemented controls at four weeks of age. A large chemical firm reports chick growth stimulation on its quaternaries in concentrations of 1 part in 2,000, 3,000 and 10,000 when added to the water.

Very recently reports have been received regarding surfactant experiments by others, many of which add corroborative evidence to our findings.

EXPERIMENTAL METHODS

I. Laboratory Trials

The great majority of our tests on surfactants and other supplements were conducted in laboratory chick batteries. In the early tests, the Rock-Hamp broiler cross was used as the experimental breed, however, we later switched to the Delaware-Hamp (Indian River) Cross because of the industry trend toward a white feathered bird.

---

* Presented at Seventh Annual Conference of the Distillers Feed Research Council Inc., Cincinnati, Ohio, Mar. 12, 1952. Proceedings Seventh Distillers Feed Conference p. 72.

An experimental trial normally consisted of 200 chicks divided into 10 individual test lots of 20 chicks each. One lot of control chicks on the unsupplemented basal diet and 9 "variables" lots were used for evaluating dietary changes. In late tests, however, we have used 2 control lots and 8 variable lots. This move has proven to be of material aid in reducing the normal experimental error.

It is important to note that all of our experiments were of 10 to 12 week's duration. Since we were primarily interested in the practical implications of the data, it was deemed necessary to carry the chicks on test until they reached market weight. Our weekly check weighings gathered over a period of several years show that fundamental differences in growth relationship often exist in comparing final weights at fryer size to those obtained at 3, 6 or 8 weeks of age. These differences have developed frequently enough to rule out consideration of short term tests for other than exploratory purposes in our laboratories.

II. Field Trials

The field trials reported on LEOC and antibiotics were conducted at Yemassee, S. C., on Christie Strain New Hampshires. The chicks were housed in groups of 200 each in hexagonal shaped colony houses of exactly the same design, with a floor area allowance of ¾ of a square foot per bird.

BASAL DIETS

Five different basal diets, carefully selected to cover a wide range of nutritional completeness, were used in evaluating the effect of surfactants. The composition of these rations is presented in Table I.

The low cost practical diet shown in column one was patterned after the high energy diets in the early reports of Matterson, Scott and Singsen,[2] except that soybean meal and Distillers Solubles were used to replace the major portion of the high cost animal protein supplements and the brewers' yeast. The modified Connecticut Broiler Ration in column two is that of Scott.[3] The low cost all-vegetable ration in column three is similar to the low cost practical diet, except that no animal protein is used in the formula. Also, in order to raise the methionine level, a corn gluten meal-soybean meal combination is used as a protein supplement rather than soybean meal alone. The corn-soya diet shown in column four is that of Briggs, *et al.*,[4] which has been used extensively in studying vitamin B_{12} and antibiotic growth response. The modified practical ration in column five is somewhat typical of high

energy diets in present day commercial use to which B_{12} and antibiotics are added to achieve a maximum growth response.

TABLE I
Basal Diets Used for Surfactant Studies

Ration ingredient	Low cost practical	Modified Connecticut	Low cost all vegetable	Corn-Soya	Modified practical
Ground yellow corn	60.00	66.25	60.00	60.50	59.25
Soybean meal (41%)	25.00	8.00	18.00	35.00	28.00
Fish meal (60%)	1.00	8.00	——	——	3.00
Meat scraps (55%)	1.00	8.00	——	——	——
Alfalfa meal (17%)	4.00	1.00	4.00	——	2.00
Distillers Solubles	5.00	4.00	5.00	——	2.00
Dried brewers' yeast	——	3.00	——	——	——
Corn gluten meal	——	——	10.00	——	——
Dried whey	——	——	——	——	2.00
Blood meal	1.00	1.00	——	——	——
Bone meal	1.50	——	1.00	2.00	1.50
Feed grade limestone	0.75	——	1.30	1.50	1.50
Salt (Iodized)	0.50	0.50	0.35	0.50	0.50
$MnSO_4$	0.02	0.02	0.02	0.02	0.03
1500A/400D oil	0.25	0.15	0.35	0.50	0.25
Choline chloride	——	0.075	——	——	——
Riboflavin	150 mg.	227 mg.	150 mg.	150 mg.	150 mg.
Niacin	——	900 mg.	——	——	——
Totals	100.02 lbs.	100.00 lbs.	100.02 lbs.	100.02 lbs.	100.03 lbs.

RESULTS

Scope of Test Information Reported, And the Identity of Materials

It is our purpose to give interested researchers the benefit of several years of "screening" work in investigating the nutritional applications of surface active agents. A certain amount of late test data, some of which is incomplete, is not yet ready for release. This report summarizes essentially all of the basic work from which our recent tests were designed. The data are presented strictly for their information value, and no bias for or against the use of any product is intended or implied.

Review of Tests on Lauryl Ethylene Oxide Condensate

I. Lauryl Ethylene Oxide Condensate as the Lone Supplement to Various Basal Diets

The majority of the early experiments on surfactants involved tests on lauryl ethylene oxide condensate fed as the lone supplement, or combined with other growth stimulants in various basal diets. This product has proven to be a remarkably consistent growth stimulator in our tests. In 23 separate laboratory experiments and 1 field trial in which this wetting agent was added to the feed, not one lot failed to show an improved growth over the controls at the end of the regulation test period. Although many of the increased growth responses were small, they were nevertheless consistently positive. In the field trial, duplicate lots of 200 chicks each fed 2.2

lbs. of LEOC per ton averaged 4.7 percent heavier than non-supplemented controls at 10 weeks of age. This conclusively demonstrated this products' merit under practical conditions.

The early work on LEOC was done with animal protein fortified basal diets, and it is in this type of diet that the product shows up to best advantage. In 7 experiments in which LEOC was added at several levels to the highly fortified Connecticut Broiler Ration, a growth improvement ranging from 4.5 to 8.9 percent and averaging 7.1 percent resulted. In view of the very excellent growth supported by this basal when fed without the supplement, the 7 percent additional gain is rather noteworthy.

Lauryl ethylene oxide condensate was less effective in all vegetable diets than in animal protein fortified basals. The extra growth response on the product averaged 6.2 percent in 4 tests on the low cost all vegetable ration, and 4.6 percent in 10 trials on the corn-soya diet. Approximately twice as much of the material was needed for best results in all vegetable diets as was required in animal protein supplemented basals. The optimum feeding levels were about 2.2 pounds per ton in the former, and 1.1 pounds per ton in the latter.

Levels as high as one pound of the product per hundred pounds of mixed ration did not affect the mortality of the chicks. Growth was improved, but not as markedly as when fed in smaller quantities.

A rather consistent growth pattern was established by chicks consuming feed containing LEOC. In almost every test, there was no growth improvement shown over the control lots until rather late in the growing period. At 5 or 6 weeks of age, the weight of the LEOC supplemented lots would be essentially equal to that of the controls. During the last 4 to 6 weeks of the test (6th to 12th week), however, the groups fed the product would gradually develop a distinct weight advantage over the controls. This typical growth curve suggested to us that the birds were able to utilize extra feed during the rapid growing period due to more rapid (or more complete) absorption of the nutrients passing through the intestine. This is felt to be a part of the effect of surfactants in promoting increased growth.

Many of the other surfactants tested have not shown as much of a tendency toward late stimulation as has LEOC. Some have been as early or earlier than antibiotics in giving a response over the controls. Ethylene diamine tetraacetic acid seems to be another consistent "late starter," although all sup-

plements tested, including antibiotics, were slow in responding at times.

II. Lauryl Ethylene Oxide Condensate vs. other Growth Stimulants

In 14 comparative tests on lauryl ethylene oxide condensate and antibiotics, the average growth response over the controls was slightly higher on the surfactant, but feed efficiency favored the antibiotics by a small margin. One test in which LEOC was combined with an antibiotic gave essentially the same results as that obtained on either one fed alone. Both LEOC and the antibiotic supplements were less active in improving growth in rations containing no B_{12} (all vegetable diets) than they were in animal protein supplemented diets.

A total of 21 tests showed that vitamin B_{12} supplements were more effective as the lone supplement to all vegetable basal diets than either lauryl ethylene oxide condensate or antibiotics. The average growth increase in 9 trials on the wetting agent was 4.6 percent over the controls. Under the same conditions, vitamin B_{12} supplements improved growth by 7.0 percent.

It is of interest to note that the growth curve on the vitamin B_{12} supplements was considerably different from that obtained on the surfactants or antibiotics. Chicks fed all vegetable basal diets supplemented with fermentation derived vitamin B_{12} got off to an early start and showed some very remarkable growth increases over the controls during the early weeks. The increase in weight of the B_{12} lots over the controls often ranged from 20 to 30 percent at the third or fourth week. After the sixth or seventh week, the effectiveness of B_{12} was sharply reduced due to the decreased demand for this factor by the chick. The final weight advantage in the B_{12} supplemented lots was still substantial at the end of the test because of the extreme early response.

In 2 out of 3 tests, the addition of LEOC to vitamin B_{12} supplements did not produce an increased gain. In the one positive test, the additive effect of LEOC was slight. The failure of lauryl ethylene oxide condensate to show a substantial additive effect when combined with B_{12} supplements is a serious disadvantage of the product in contrast to the well established synergistic effect of B_{12} and antibiotics. Exactly why LEOC will not combine to advantage with B_{12} supplements is not readily evident in view of its strongly beneficial effect in the Connecticut basal. Many of the other surfactants

tested have shown an excellent synergistic effect with vitamin B_{12} supplements.

In 7 experiments, vitamin B_{12}-antibiotic combination supplements were consistently superior to LEOC alone. No growth promoting advantage was shown by adding the product to a B_{12}-antibiotic supplement.

No definite conclusions are possible regarding two separate trials comparing 3 hydroxy, 4 phenylarsonic acid and LEOC. Results on the surfactant were positive in both cases, while one positive and one negative response resulted on the arsenical. Preliminary evidence of a beneficial effect on feathering and general health was noted on the arsenical supplement.

CLASSIFIED TYPES OF SURFACTANTS IN CHICK RATIONS

Immediately following the discovery that lauryl ethylene oxide condensate produced a growth response in chicks, it was decided to test as many different types of surfactants as possible in order to determine their effectiveness for this purpose. From the many thousands of compounds falling under the broad "surfactant" category, 15 classified types were set up covering a wide range of physical and chemical properties. At least one representative product of each of the classified types listed below was tested, all at a supplemental level of 1.1 pounds per ton:

No.	
1.	Alkyl Amine
2.	Alkyl Amide
3.	Alkyl Sulfate
4.	Alkyl Phosphoric Ester
5.	Alkyl Polyethylene Oxide
6.	Sodium Alkyl Sulfate
7.	Sodium Alkyl Phosphonate
8.	Sodium Alkyl Aryl Sulfonate
9.	Sodium Alkyl Sulfo Amide
10.	Sodium Alkyl Sulfo Amine
11.	Sodium Ethylene Diamine Tetraacetic Acid
12.	Pentaerythritol Monostearate
13.	Sorbitan Monostearate
14.	Protein Condensation Product*
15.	Quaternary Ammonium Salts

*Chemical composition unknown.

In our tests, numbers 1 and 13 failed to show any growth promoting effect. Numbers 2, 3, 6, 10, 11, 12 and 14 gave responses at least 2 percent over the control but less than 5 percent higher. Numbers 4, 5, 7, 8, 9 and 15 gave responses greater than 5 percent over the controls in at least one test. Four types, namely, the alkyl aryl sulfonates, sodium ethylene diamine tetraacetic acid, the quaternary ammonium compounds, and the alkyl polyethylene oxides appeared superior to the others tested.

Although those surfactants listed above cover a wide variation in chemical and physical properties, the possibilities for the development of outstanding individual compounds through further research are extremely good. It is realized

that our work at best has merely "scratched the surface" in this direction.

COMMERCIAL LAUNDRY PRODUCTS IN CHICK RATIONS

One of the most interesting phases of our surfactant work was a series of tests on commonly available commercial laundry products, both soaps and synthetic soaps.

One product produced a positive growth response in 4 consecutive tests ranging from a low of 1.4 percent over the controls to a high of 8.0 percent. The average increased gain was 5.4 percent.

In tests on seven other products, one failed to show any effect on growth, two gave a minor growth improvement, and four others were rather active growth stimulators. The average growth increase on the better products was about 7.0 percent at 12 weeks, or approximately two-tenths of a pound per bird.

The results of these tests on the commercial laundry products indicate considerable variability in stimulating effect among materials of essentially the same composition. This may be due in part to the percentage and type of inorganic "builders" used in these products.

TESTS ON INORGANIC AND ORGANIC "BUILDERS" USED IN COMMERCIAL LAUNDRY PRODUCTS

Preliminary results of tests on certain inorganic and organic "builders" used in commercial laundry products indicate that none of the materials by themselves improve early chick growth. Among the products tested were sodium tetrapyrophosphate, sodium tripolyphosphate, extracted inorganic fractions of commercial synthetic detergents, sodium sulfate and carboxymethyl cellulose. It is apparent, however, that certain of these materials show a synergistic effect when added to various organic surfactants.

CHICK TESTS ON FORMULATED SURFACTANTS

Recent tests have shown that the specific effect of certain individual surfactants can be combined in specially prepared products or mixtures. These materials, which we have termed "formulated surfactants" show considerable promise in their ability to improve both growth and feed efficiency. Since these products have the greatest potential of any of the surfactants studied to date, the data from a typical trial are presented in this abstract report.

As shown in Table II, six out of seven surfactant fed lots exceeded the weight of the duplicate controls by more

than 10 percent. (Better than ¼ pound per bird.) One test lot showed a 5.9 percent growth improvement at this age.

These 10-week responses exceed the average obtained on straight antibiotic supplements fed in the same basal diet. In the presence of added B_{12}, the formulated surfactants have shown a strong synergistic effect. The merits of these products will be considered further in a later discussion titled "What are the Future Possibilities for Surfactants?"

TABLE II

Chicks Tested on Formulated Surfactants in the Corn-Soya Basal Diet

Series	Test No.	Breed	No. chicks tested	Basal diet	Age at final weighing, days	Supplement to basal	Pounds of supplement per ton	Final weight grams av. M-F	Grams fed per gram gain	Growth of variables vs. controls
1	1	*IR	**40	†C-S	70	None	None	1085	2.87	——
	2	IR	20	C-S	70	‡FS#1	5.0	1199	2.82	+10.5%
	3	IR	20	C-S	70	FS#2	5.0	1262	2.48	+16.5%
	4	IR	20	C-S	70	FS#3	5.0	1199	2.66	+10.5%
	5	IR	20	C-S	70	FS#4	5.0	1244	2.78	+14.7%
	6	IR	20	C-S	70	FS#5	5.0	1149	2.79	+ 5.9%
	7	IR	20	C-S	70	FS#6	5.0	1230	2.58	+13.4%
	8	IR	20	C-S	70	FS#7	5.0	1208	2.84	+11.3%

*IR = Indian River Cross.
**Duplicated control lots.
†C-S refers to Corn-Soya diet (Table I).
‡FS refers to "Formulated Surfactant".

SUMMARY OF TABLE II

Basal diet	Total chicks tested	Growth of variables vs. controls Individual tests	Average	Grams feed per gram gain	Average mortality
1. Corn-Soya					
a. Controls	40	——	——	2.87	5.0%
b. Variables ..	140	+10.5, 16.5, 10.5, 14.7, 5.9, 13.4, 11.3%	+11.8%	2.73	7.1%

OBSERVATIONS AND CONCLUSIONS

I. Consistency of the Growth Stimulating Effect of Various Supplements

Since the development of vitamin B_{12}, antibiotic and arsenical supplements as growth stimulators for poultry and livestock, a great deal of controversy has arisen concerning the consistency of growth improvement on these products.

Anyone who has dealt intimately with living things knows that biological processes cannot be controlled as can a chemical reaction. It is therefore reasonable to expect con-

siderable variability in the degree of positive response *as well as an occasional negative response* in chick tests on any product. Briggs[4] and others have reported a certain number of failures in tests with antibiotic supplements. In our own tests, negative results were obtained in 2 of the 10 separate experiments. The normal percentage of positive responses on antibiotics is felt to be higher than this, however, this example does show the inherent variability of experimental data.

A very high degree of correlation was noted between the growth response on the antibiotics and surfactants in relation to the control lots in a large majority of our side by side comparisons. When one product showed a sharp increase over the controls at the end of the test period, the other was usually in the same relative position, and vice versa. This observation adds weight to the hypothesis that the two products react similarly on chicks.

One of the early objectives of our surfactant studies on chicks was to establish an idea of the growth promoting consistency of these products through extensive repetition of experiments. This has been a major consideration in delaying the release of our data for a period of several years.

Of 63 separate surfactant experiments (not including controls) in which these products were added as the lone supplement to various basal diets at many feeding levels, a total of 60 positive and 3 negative results were obtained. Although many of the positive responses were minor, this high level of probability (95%+) establishes beyond reasonable doubt the theory of growth stimulation by these products, and indicates a high level of consistency under our conditions.

It should be repeated again that all of the growth responses mentioned are male-female averages measured on the basis of market weight for purposes of direct practical application. A numerically low percentage of increased gain in a test lot at this weight is substantial in terms of actual pounds.

II. Theories Concernnig the Growth Stimulating Action of Surfactants

We do not know as yet why certain surface active agents have a growth promoting effect on chicks, however, two principal ideas concerning the mode of action have been developed.

Unpublished bacteriological tests of a preliminary nature conducted in our laboratories indicate that the theory of selective bacterial inhibition proposed by others as the reason for the effectiveness of antibiotic supplements may also apply to surfactants. Strong inhibitory action was shown by

several surfactants on cultures of bacteria other than the *colli-aerogenes* type which were isolated from fresh droppings. It is interesting to note in this connection that a standard bacteriological method for water analyses employs sodium lauryl sulfate in a 1 to 10,000 concentration as an inhibitor for bacteria other than the *coli-aerogenes* type which are present in water.

Selective inhibition rather than a general inhibition of bacteria seems to be of importance, otherwise, the highly bactericidal quarternary ammonium salts would be more effective growth promoters than any other surfactant. This is not the case, although the "quats" are good for the purpose.

As mentioned previously, more rapid absorption of nutritional factors from the intestine as a result of the "wetting" action of the surfactants appears to be a logical addition to the selective bacterial inhibition theory. Calculations on the final surfactant to water relationship in the body of the chick indicate that surface tension can be appreciably altered when the birds are consuming large amounts of feed and water.

III. What Are The Future Possibilities for Surfactants?

The important considerations in evaluating future possibilities for the practical use of surfactants are cost and growth promoting activity.

A lauryl ethylene oxide condensate has compared favorably to three different antibiotics as the lone supplement to various diets. Unlike the antibiotics, it has not proven itself synergistic with B_{12} supplements. Its supplemental cost per ton is about the same as that for a B_{12}-antibiotic product. Since the B_{12}-antibiotic combination supplements are better growth stimulators, it offers no apparent competition to these products.

The salts of ethylene diamine tetraacetic acid and the quaternary ammonium compounds are rather expensive at the present time. Some very promising results have been obtained with these materials, but it is not likely that they will have commercial possibilities in view of the promise shown by the lower cost formulated products.

The commercial laundry products and the alkyl aryl sulfonates are cheap enough to merit consideration. The high supplemental level required, and the relative inconsistency of the commercial laundry products makes their use unlikely. The properties of the alkyl aryl sulfonates have not been investigated thoroughly enough to comment on their possibilities.

Recent experiments on formulated surfactants indicate that certain of these materials might provide strong economic and nutritional competition to the antibiotic and B_{12}-antibiotic supplements. While considerable testing is still required, the possibility exists that a formulated surfactant will reach the stage of commercialization.

The research of others in this field will bring to light many facts concerning this general idea which are now completely unknown. Although there have been a certain number of studies on livestock using surfactants, a broad field for pioneering research in this connection is opened up. The newness of this concept, and the limited amount of work in this field thus far, makes any predictions for the future highly speculative. In any event, it is hoped that fundamental advances in the ever continuing quest to satisfy the nutritional needs of farm animals may result from future research efforts of this nature.

SUMMARY

Data are summarized concerning 108 experimental groups totaling 3,500 chicks which were fed various growth stimulants, including surfactants, antibiotics, vitamin B_{12} and arsenicals in all types of basal diets. Positive growth responses, many of them minor, were obtained in 60 of 63 experiments in which surfactants were fed. Of the surfactants reported, lauryl ethylene oxide condensate, sodium ethylene diamine tetraacetic acid, quaternary ammonium compounds, sodium alkyl aryl sulfonate and certain specially formulated products gave the best growth stimulating effect in market weight comparisons. Low cost formulated surfactants appear to have a good chance for potential commercial use if present tests continue to be favorable.

Two theories are proposed concerning the mode of action of surfactants in stimulating growth. These are (1) selective inhibition of non *coli-aerogenes* bacteria in the intestine of the chick, and (2) more rapid assimilation of nutritional factors from the intestine due to the wetting properties of surfactants.

A great deal of pioneering research is required in order to determine the value of surfactants for other types of poultry and livestock, although preliminary evidence indicates they will be applicable. Continued surfactant research in our laboratories and elsewhere may prove of considerable value in explaining nutritional responses previously classified as due to "unknown factors."

BIBLIOGRAPHY

1. Riedel, B. B., C. W. Barber and T. A. S. Hays. The Anthelmintic Activity of Quaternary Ammonium Compounds in Chickens Infected with *Ascaridia galli*. *Poultry Science 28:* 830-833, 1949.
2. Matterson, L. D., H. M. Scott and E. P. Singsen. Nutritional Factors Influencing Growth and Efficiency of Feed Utilization. I. The Effect of the Source of Carbohydrate. (Abstracts.) *Poultry Science 26:* 554, 1947.
3. Scott, H. M., and W. A. Glista. Mimeographed bulletin from University of Illinois Agricultural Experiment Station, Champaign, Illinois, 1948.
4. Briggs, G. M., E. G. Hill and M. J. Giles. Vitamin B_{12} in All-Plant Rations for Chicks and Sparing Activity of Methionine and Choline. *Poultry Science 29:* 723-735, 1950.

RECENT FINDINGS IN POULTRY NUTRITION

G. F. COMBS

University of Maryland,
College Park, Md., U.S.A.

The progress which has been made in poultry nutrition during recent years clearly exemplifies the fundamental role of basic and applied research in meeting the needs of the industry. The rapid application of such scientific developments as those pertaining to the use of antibiotics and vitamin B_{12} supplements in poultry feed has materially lowered the cost of production of poultry meat and permitted the poultryman to compete favorably in the production of animal products. Some of the recent findings made in the Poultry Department, University of Maryland, are briefly presented.

CHICKS REQUIRE AT LEAST TWO UNIDENTIFIED GROWTH FACTORS

Evidence has been obtained that clearly shows that at least two different unidentified growth factors are required by the chick. One of these factors is supplied by certain liver preparations and dried brewers' yeast, and the other is supplied by dried whey. Fish meal and crab meal also contain an unidentified factor (presumably the one found in the liver preparations) while butyl fermentation products contain another. The unidentified factor present in butyl fermentation products is also supplied by dried whey and dried brewers' yeast. Antibiotic supplementation (aureomycin or penicillin) of practical rations has been found to reduce the need for supplements containing these unidentified growth factors.

It has been shown that the unidentified factor in liver is transmitted by the dam to the chick in appreciable quantities; however, hens housed on wire floors and fed a ration containing no sources of these unidentified factors produce chicks that respond to the unidentified factor supplements. Consequently, it is desirable to maintain a special laying flock in order to insure chick progeny suitable for use in assaying for unidentified growth factors. Studies with poults, however, have shown that this procedure is not necessary since the poult requires a dietary source of the factor present in liver even though the dams received a complete ration.

FEEDING TRIALS REVEAL EFFICIENT GAINS

The first broiler feeding trial conducted at the experimental farm, Salisbury, clearly demonstrated that 3-pound broilers can be grown in 10 weeks with less than 3 pounds of feed per pound of live weight. In this trial, the average 10-week weight of all birds was 3.06 pounds, with an average of 2.81 pounds of feed required per pound of live weight. The addition of either terramycin at the rate of 10 gms. per ton or an animal protein supplement (2½ or 5% fish meal or 5% crab meal), consistently improved the average weight and feed utilization. The best results were obtained, however, when the antibiotic was added in the presence of an animal protein supplement. The three groups of broilers fed terramycin and an animal protein supplement averaged 3.12 pounds with a feed requirement of 2.73 pounds per pound of live weight. The addition of terramycin also reduced mortality during the 10 weeks of this trial.

VITAMIN B_{12} REQUIREMENT AFFECTED BY AMINO ACID LEVELS

Research findings demonstrate that vitamin B_{12} is concerned in protein metabolism, and that there is a close interrelationship in the requirement of vitamin B_{12} and the level of certain amino acids. Certain amino acids have a marked effect on the requirement of the chick for vitamin B_{12}. Conversely, the level of vitamin B_{12} determines in part the level of certain amino acids that may be fed without depressing growth. Since soybean-corn-type rations contain relatively high levels of leucine and glycine, amino acids that increase the need for this vitamin, the vitamin B_{12} requirement would be expected to be greater than in rations containing a more favorable amino acid balance.

ANTIBIOTIC MAY SPARE CERTAIN NUTRIENTS

Studies have also been conducted to determine the effect of dietary antibiotics upon the requirement of the chick for the amino acids—lysine, methionine, and tryptophan. The dietary requirement for tryptophan was slightly reduced by feeding aureomycin, but the requirement for methionine and lysine was not decreased when an antibiotic was included in the feed.

Other experiments were designed to study the effect of dietary antibiotics upon the bacterial flora of the ceca and to determine if any correlation exists between changes in bacterial types and the growth response of the chick. The evidence suggests that bacteria synthesize an unidentified growth factor(s) that was responsible in part for the improved chick growth obtained when antibiotics were fed in these trials.

OTHER STUDIES

Vitamin B_{12} has been found to reduce the requirement for choline and methionine. The fat content of the liver increased in the absence of choline or vitamin B_{12}. The level of essential choline required in the presence of adequate amounts of vitamin B_{12}, methionine, and betaine was found to be .06% of the total diet.

The results of three experiments also show that green manganous oxide is satisfactory as a source of manganese in poultry rations.

CHICKENS BUILD PROTEIN

Green plants and microorganisms can build certain amino acids by using sulfuric acid and its salts, but until recently this natural process was believed impossible for animals. It was presumed that livestock got all their sulfur-containing amino acids indirectly from eating plants or the meat of other animals that ate plants. But Bureau of Animal Industry scientists have traced radioactive sulfur right to the proteins in eggs laid by hens injected with dilute sulfuric acid. —Morley A. Jull

REVIEW OF POULTRY PUBLICATIONS

Compiled by J. W. Kinghorne,

1365 Iris St., N.W.

Washington 12, D.C., U.S.A.

GENETICS

HUTT, F. B. (Cornell U., Ithaca, N. Y.)
SNOW-WHITE DOWN IN THE CHICK. *Jour. Heredity 42:* 117-120. 1951.—Snow-white (sw) is a unifactorial, autosomal, recessive mutation, which, in the homozygous state, removes the color from the down of chicks that would otherwise be creamy, yellow, or greenish white in color. The contrast between snow whites and other whites is so great that accurate classification can be made at a single glance. It has no recognizable effects in later plumages, or on black pigment, and does not interfere with the deposition of carotinoid pigments in the shanks, skin, and eggs. Red down is unaffected. Viability of snow-white chicks and embryos is unaffected by the mutation. In tests for linkage it proved to be independent of 9 different genes, 8 of which are "markers" for four of the five autosomal linkage groups known in the fowl.—*F. B. Hutt.* (Biological Abstracts)

LERNER, I. MICHAEL. (U. California, Berkeley.)
PRINCIPLES OF COMMERCIAL POULTRY BREEDING. *California Agric. Expt. Sta. Manual 1:* 1-47. 1951.—A semi-technical exposition of the principles of population genetics in application to poultry improvement. The first section (The Genetic Background) deals with the basis of inheritance, genetic and phonotypic variation and heritability. The 2d section (Selection) discusses bases and criteria of selection, comparing individual and family testing, etc. The 3d section (Mating) discusses mating systems including inbreeding. The 4th section (Practical Applications) deals with formulation of breeding plans. The final section (The Commercial Poultryman) addresses itself to poultry keepers emphasizing the problem of choosing sources of stock for commercial production.—*I. M. Lerner.* (Biological Abstracts)

TAYLOR, LEWIS W., I. MICHAEL LERNER, and D. C. LOWRY. (U. California, Berkeley.)
BLOOD-SPOTTING IN EGGS. *California Agric. 5:* 3, 13. 1951.—A ten-generation selection experiment with single comb White Leghorn chickens demonstrated that blood-spotting in eggs can be partly controlled by breeding. Blood-spotting was increased from 0.6% to 22.8% by selection for increased spotting while it remained fairly constant in lines selected for decreased spotting. Combined individual and family selection pressure should be maintained to keep blood-spotting at a minimum in production-bred flocks. *G. W. Bohn.* (Biological Abstracts)

PHYSIOLOGY

BRADFIELD, J. R. G. (U. Cambridge.)
RADIOGRAPHIC STUDIES ON THE FORMATION OF THE HEN'S EGG SHELL. *Jour. Exptl. Biol. 28:* 125-140. 1951.—By means of X-ray photographs, the rate of deposition of shell and changes in volume of the egg were studied. It was found that rate of deposition of mineral matter in the shell follows an S-shaped curve. The egg undergoes a 25% increase in volume during the first few hrs. in the shell gland. Just before the egg is laid, it undergoes a 180° rotation in the horizontal plane so that the blunt end emerges first.—*Sidney Mittler.* (Biological Abstracts)

DRIMMELEN, GOVERT CORNELIUS van.
ARTIFICIAL INSEMINATION OF BIRDS BY THE INTRAPERITONEAL ROUTE. A STUDY IN SEX PHYSIOLOGY OF PIGEONS AND FOWLS WITH REPORTS UPON A MODIFIED TECHNIQUE OF SEMEN COLLECTION, AND A NEW TECHNIQUE OF INSEMINATION, AND OBSERVATIONS ON THE SPERMATOZOA IN THE GENITAL ORGANS OF THE FOWL HEN. *Onderstepoort Jour. Vet. Res. Suppl. 1:* 3-212. 1951.—Pigeon cocks were held upside down between the operator's knees and the left thumb and forefinger grasped the vent in the milking procedure with some pressure on the abdomen while the right hand aspirated the semen with a glass syringe. With fowl cocks the bird was restrained on the operator's knees with a wire loop from the bird's legs to a stirrup for the operator's right foot. After massgae of the abdomen with the right hand, the left hand was used for a milking effect grasping the copulatory organ deep in the walls of the abdomen and leaving the right hand free to collect the semen in the receptacle. Semen was injd. intraperitoneally over the obturator notch between the ischium and the posterior process of the pubic bone. Such insemination did not seriously affect egg production nor health, although some birds were lost with peritonitis. Onset of fertility was usually immediate; the first ovum liberated after insemination was fertile. The length of the fertility period was similar by this means to that of others who separated cocks from hens but in 45 cases (10.78 days) slightly less than in 13 controls fertilized by coitus or artificial insemination per vaginam (13.85 days). The max. of 25 days exceeded by 3 days the max. reported locally in controls. The no. of eggs fertilized by one injn. (4.78) averaged less than controls (6.69) but the max. on record (14 eggs) was exceeded (16, 15, 15). The fertility of eggs by this method (82.7%) and controls (82.%) was similar; no difference was noted in hatchability. All-glass instruments with relatively wide (1 mm.) lumen and with blunt penetrating ends were most suitable for intraperitoneal insemination In cock birds 292 consecutive semen collections (98.6% success) were made with an average of 0.45 cc. semen. The fertility of semen samples used by the intraperitoneal route was higher than when introduced into the vagina. Larger doses of semen were followed by better fertility and a longer fertile period. Storage up to 2 hrs. under liquid paraffin had little effect but further storage and dilution lowered fertility. Mixed samples of semen tended to be reduced to the quality of the poorest component. Deposition of semen in the region of the ovary was more successful in producing fertility than near the point of entry. The fertilizing quality of semen was more important than the route of introduction or the amount used if above 0.1 cc. Using the capillary action of fine glass tubes, spermatozoa could be demonstrated only in the lumen of the infundibulum (3-14 da. following insemination by various methods). Sperm concns. were found 4, 6, and 8 days after intraperitoneal insemination or copulation in the mucosa of the chalaziferous region of the infundibulum (sperm-nests).—*J. F. Ryff.* (Biological Abstracts)

FRAENKEL-CONRAT, H., and E. D. DUCAY. (Western Region Res. Lab., U.S. Dept. Agric., Albany, Calif.)
THE NUCLEIC ACID OF EGG WHITE. *Biochem. Jour. 49:* xxxix. 1951.—*Abstract.* (Biological Abstracts)

McCLYMONT, G. L., H. GREAVES, and D. C. DUNCAN.
NO RESPONSE IN EGG PRODUCTION TO FEEDING THYROPROTEIN. *Agric. Gaz. N. S. Wales 62:* 46. 1951.—Overseas experiments have indicated that substantial increases in late summer and autumn production, particularly from 2-year hens, may be obtained under some conditions by feeding birds a material known as thyroprotein, or iodinated casein. This material contains thyroxine, the active material of the thyroid gland. Expts. carried out at the Poultry Experiment Farm, Seven Hills, failed to show any benefit from the feeding of this material under Australian conditions.—*A. J. Loustalot.* (Biological Abstracts)

SHARMA, GANPATI PARSHAD. (Government Coll., Hoshiarpur, East Punjab, India.)
MORPHOLOGY AND NATURE OF BLOOD AND MEAT SPOTS IN HEN'S EGGS. *Res. Bull. East Punjab Univ., Zool. 9:* 103-110. 1950.—Blood spots in eggs are due to intra-follicular bleeding. If the hemorrhage is only slight it results in the formation of thin sheets and streaks of blood in close adherence to the vitelline membrane. Copious bleeding leads to the formation of large blood clots which, if separated from the yolk, are included in the egg albumen and form colored meat spots. White meat spots are formed in the oviduct by the coagulation of albumen around a degenerated colored meat spot, degenerating free yolk, or even broken egg membranes. The so-called "bloody white" appears to be due to the dissolution of a large blood spot or a colored meat spot. Cloudy white may be formed by the disintegration of the chalazae and the dispersion of degenerating free yolk granules.—*Auth. summ.* (Biological Abstracts)

SHARMA, GANPATI PARSHAD. (Government Coll., Hishiarpur, East Punjab, India.)
SOME OBSERVATIONS ON THE FORMATION OF THE HEN'S EGG WITH SPECIAL REFERENCE TO THE CHALAZIFEROUS LAYER AND THE CHALAZAE. *Res. Bull. East Punjab Univ., Zool. 7:* 83-89. Illus. 1950.—The chalaziferous layer is secreted in the posterior portion of the infundibulum, the so-called "chalaziferous region" of the oviduct. In eggs removed from the posterior magnum a faint whitish cloud of mucin fibers can often be observed in that end of the egg which is towards the isthmus. These mucin fibers are the precursors of the chalaza. Simultaneously with the appearance of the mucin fibers the inner layer of thin albumen also becomes visible. In the isthmian eggs faint whitish clouds of mucin fibers can be seen at both poles of the yolk. The normal twisting of the chalazae is observed only after the egg has been in the uterus for some time. This takes place due to the rotation of the thick albumen round the yolk. The outer layer of thin albumen becomes distinct only in the uterus. The mode of formation of the inner and the outer layer of thin albumen is discussed.—*Auth. summ.* (Biological Abstracts)

WILSON, WILBOR O., and THEODORE H. PLAISTER. (U. California, Davis.)
SKIN AND FEATHER TEMPERATURES OF HENS KEPT AT CONSTANT ENVIRONMENTAL TEMPERATURES. *Amer. Jour. Physiol. 166:* 572-577. 1951.—Skin and feather temps. were taken with a contact thermocouple and a Hardy dermal radiometer, in White Leghorns and New Hampshires, at environmental temps. of 74°, 80°, 86° and 90°F. Deep body temp. as well as skin temps. varied within the range studied. Highest skin temp. occurred on the femur and breast, while the temps. of comb, wattle, and shank (anterior) were lower and varied more with environmental temp. Gradients existing in skin temp. may be related to location on the bird and to air temp. A negative correlation between temp. of either comb or shank and deep body temp. demonstrates that they act as heat-loss mechanisms.—*W. O. Wilson.* (Biological Abstracts)

NUTRITION

BECHTEL, H. E. (General Mills, Inc., Detroit, Mich.)
HOW FAR CAN YOU TRAVEL ON ANTIBIOTICS. *Feedstuffs 23:* 18. 1951.—An antibiotic is described as a drug that prevents, injures or destroys life. The current leaders in feeds for poultry and swine are penicillin, aureomycin, terramycin, streptomycin and bacitracin. Insofar as these farm animals are concerned, the antibiotics when effective actually are probiotics by virtue or promotion of growth and vigor. The consensus of current opinion is that the growth effects shown by antibiotics in poultry rations somehow are associated with the influence of the antibiotic on the intestinal tract. Taken individually no one nutrient can be regarded as more important than any other. There are evidences that unbalanced rations can be more serious in their effects than outright deficiencies in certain nutrients. More facts from many sources are needed to better understand and use antibiotics in poultry rations.—*H. L. Wilcke.* (Biological Abstracts)

BOYD, G. S. (U. Edinburgh.)
CHOLINE METABOLISM IN THE EMBRYO CHICK. *Biochem. Jour. 49:* vii. 1951.—*Abstract.* (Biological Abstracts)

COMBS, G. F. (U. Maryland, College Park.)
GREEN MANGANOUS OXIDE AS A SOURCE OF MANGANESE FOR POULTRY. *Feedstuffs 23:* 54. 1951.—Green manganous oxide (MnO) in suitable source of Mn and can be used economically in the feeding of poultry. It is available in quantities of considerable importance to the feed industry.—*H. L. Wilcke.* (Biological Abstracts)

COUCH, J. R. (Texas A. and M. Coll., College Station.)
B_{12} SUPPLEMENTS FOR POULTRY. *Flour and Feed 51:* 20. 1951. —An all-vegetable protein ration can be used economically for broilers when supplemented with dried whey, along with B_{12} and antibiotic factors. Antibiotic supplements from aureomycin and penicillin give increased growth rates in chickens and turkeys. B_{12} and antibiotic supplements improve the feathering in both broilers and turkey poults.—*M. J. Blish.* (Biological Abstracts)

DAVIS, R. L., and G. M. BRIGGS. (U. Minnesota, St. Paul.)
THE VITAMIN B_{12} REQUIREMENT OF THE CHICK. *Poultry Sci. 30:* 628-629. 1951.—From studies of the vit. B_{12} requirement for normal undepleted chicks fed a practical diet the minimum level for optimum growth was concluded to be 1.5-2.0 μg./kg. of ration. The presence of an antibiotic did not alter the vit. B_{12} requirement. A level of 4.4 μg./kg. in practical rations was suggested to provide an ample margin of safety.—*Authors.* (Biological Abstracts)

DeSARASQUETA, PEDRO A.
LA ALIMENTACION AVICOLA EN SUS DIVERSOS ASPECTOS.. [POULTRY NUTRITION.] *Bol. Fac. Agron. y Vet. Univ. Buenos Aires 25:* 1-94. 1948.—Included in this bulletin are a discussion of the general chemistry of feeds, nutritive values, nutritive ratios, a minimum protein standard, the Ca-P ratio, etc. Poultry feeds are considered under the following group headings: cereals and by-products, seeds (sunflower, soybean, hemp), roughage (clover, alfalfa, sprouted oats, roots and tubers), meat and by-products, milk and its derivatives, vitamin supplements, mineral supplements, and mixtures. Tables give the composition of a very complete list of feeds as to the usual nutrients, Ca, P, Mn, vitamins, and eight principal amino acids. Desirable rations are discussed at some length and nutritive requirements and standards are given for growing, laying, fattening and maintenance rations.—*H. A. Smith.* (Biological Abstracts)

GRAU, C. R.
COTTONSEED MEAL FOR CHICKS. *California Farmer 194:* 76. 1951.—Expeller-type cottonseed meal can be fed at levels as high as

40% of the diet for chick-starting, broiler-fryer and growing rations but such rations should not be fed to laying hens because of its adverse effect upon interior egg quality, particularly after storage.—*S. J. Lynch.* (Biological Abstracts)

HAYWARD, J. W. (Archer-Daniels-Midland Co., Minneapolis, Minn.)
RECENT DEVELOPMENTS IN TURKEY FEEDING. *Feedstuffs 25:* 22. 1951.—Results of expts. with high-energy vs. conventional turkey starter show that conventional pellets gave as good growth as high-energy mash. The high-energy starter had to be pelleted to excel the conventional pellets in growth rate. However, in both instances of mash and pellets, the high-energy feeds had an advantage of from 0.3 to 0.4 lb. less feed required per lb. of gain than for the conventional starter as mash or pellets.—*H. L. Wilcke.* (Biological Abstracts)

HENDERSON, P. D. (Bowman Feed Prod. Inc., Holland, Mich.)
PIGMENTATION STUDIES IN BROILERS. *Feedstuffs 23:* 36-37. 1951.—Using the method of Heiman and Tighe, it was found that the amount of increased pigmentation in broilers is in direct proportion to the quantity of xanthophyll concentrate added to the ration, but that pigmentation is not dependent upon xanthophyll alone. Other carotenoids also exert some effect upon pigmentation. Synergistic action is indicated between yellow corn and other xanthophyll sources.—*H. L. Wilcke.* (Biological Abstracts)

KOHLER, G. O., and W. R. GRAHAM, JR. (Cerophyl Lab., Kansas City, Mo.)
A CHICK GROWTH FACTOR FOUND IN LEAFY GREEN VEGETATION. *Poultry Sci. 30:* 484-491. 1951.—The expressed juice of forage crops such as alfalfa, clover or grass contains an unidentified growth factor for chicks. The growth factor is not identical with "animal protein factor," whey factor, vitamin B_{12}, "antibiotic effect," or "known vitamins." The new growth factor is destroyed by drying whole forage crops. Practical type rations do not supply adequate amts. of the growth factor. Vacuum dried pork liver was a fair source of the growth factor. Fish meal, fish solubles, meat meal, rice bran, grains and grain byproducts, dried distillers' solubles and dried whey were poor sources of the growth factor.—*Authors.* (Biological Abstracts)

LIENER, IRVIN E. (U. Minnesota, St. Paul.)
THE INTRAPERITONEAL TOXICITY OF CONCENTRATES OF THE SOYBEAN TRYPSIN INHIBITOR. *Jour. Biol. Chem. 193:* 183-191. 1951.—Intraperit. injn. of a single dose of crude trypsin inhibitor prepared from raw soybean meal produced death in rats and chicks within 48 hrs., the LD_{50} being 200 and more than 2000 mg./kg., respectively. Repeated injns. at a level of 130 mg./kg. inhibited growth in proportion to the frequency of injn. Treatment with acid destroyed 95% of the antitryptic activity but relatively little of the capacity to inhibit growth. The growth-inhibitor was insoluble at pH 4.7. Addition of methionine to the basal ration did not alter the growth-depressing effect of the inhibitor.—*I. E. Liener.* (Biological Abstracts)

MacINTYRE, T. M., and C. D. T. CAMERON. (Dominion Exptl. Farm, Nappan, Nova Scotia.)
CLAM SHELL, LIMESTONE, AND OYSTER SHELL WITH AND WITHOUT INSOLUBLE GRIT AS A SOURCE OF CALCIUM FOR THE GROWING CHICKEN. *Sci. Agric.* [*Ottawa*] *31:* 429-434. 1951.—Local supplies of clam shell, limestone and oyster shells found in the Maritime Provinces were tested as a source of Ca for growing chickens. All 3 provided adequate Ca when fed to growing chickens to 6 weeks of age.—*Authors.* (Biological Abstracts)

MARTEL, FERNAND, ROGER GAUDRY, and ROSAIRE GINGRAS. (Laval U., Quebec, Canada.)
REMPLACEMENT PARTIEL DE L'ARGININE PAR LA PENTAHOMOSERINE DANS LA RATION DU POULET. [PARTIAL RE-

PLACEMENT OF ARGININE BY PENTAHOMOSERINE IN THE DIET OF THE CHICK.] *Rev. Canadienne Biol. 10:* 246-248. 1951.—The procedure of Klose et al. showed that in the chick pentahomoserine partially replaced arginine in a diet deficient only in this amino acid.—*Jay Roberts.* (Biological Abstracts)

McGINNIS, JAMES, JOEL R. STERN, R. A. WILCOX, and J. S. CARVER. (State Coll. Washington, Pullman.)

THE EFFECT OF DIFFERENT ANTIBIOTICS ON GROWTH OF TURKEY POULTS. *Poultry Sci. 30:* 492-496. 1951.—Turkey poults were fed diets composed largely of practical type ingredients, supplemented with crystalline vit. B_{12} and with different antibiotics. Addition of crystalline vit. B_{12} to a deficient diet gave only a slight increase in growth either in the absence of or the presence of aureomycin. Addition of aureomycin, terramycin, penicillin or streptomycin to the basal diet improved growth. Penicillin appeared to be slightly more effective than the other antibiotics which were fed. A greater growth response to antibiotics was obtained with turkey poults fed a diet containing fish meal than a diet in which soybean oil meal supplied all of the supplementary protein. This finding suggests the presence of an unidentified factor in fish meal which is different from the recognized vitamins.—*Authors.* (Biological Abstracts)

PETERSON, D. W.

ALFALFA MEAL IN CHICK RATIONS. *Flour and Feed 51:* 20. 1951.—The growth-depressing effect of feeding high levels of alfalfa meal can be overcome by the addition of cholesterol to the diet. Sterols prepd. from the unsaponifiable fraction of soybean oil are also effective as is the sterol-containing fraction occurring in tall oil.—*M. J. Blish.* (Biological Abstracts)

ROTHERMEL, W. A.

PROTEIN SUPPLEMENTS. *Flour and Feed 51:* 9. 1951.—Several, but not all, antibiotics stimulate growth in chickens, turkeys and pigs, but they do not remove the requirement for the known B vits. Care should be exercised in feeding antibiotics to ruminants, and instances of adverse effects have been noted.—*M. J. Blish.* (Biological Abstracts)

SIEVERT, C. W.

THE ROLE OF BETAINE. HOW IT CAN BE USED IN FEEDS. *Feed Bag 27:* 37. 1951.—The 3 methyl groups of betaine can be detached and can combine with other compounds. Betaine, choline, and methionine can and do serve as methyl donors. Betaine can be used to spare methionine when methionine is being used to supply methyl groups. Recent work comparing substitution of betaine for choline indicates that with practical poultry rations betaine has marked effect in stimulating growth and prevention of perosis.—*H. L. Wilcke.* (Biological Abstracts)

ANONYMOUS.

ANTIBIOTICS IN FEED. *Amer. Egg and Poultry Rev. 12:* 64. 1951.—From experiments conducted at the Agric. Research Center at Beltsville, Md., it was found that chickens grew best on a 19% protein diet when 0.5% of volume of feed was aureomycin fermentation by-product or if feed contained 20 G. crystalline aureomycin per ton.—*H. G. Lindquist.* (Biological Abstracts)

MINERAL ADVISORY SUBCOMMITTEE. Nutrition Council, American Feed Manufacturers Association.

PHOSPHORUS SUPPLEMENTS. *Flour and Feed 51:* 14. 1951.—Definitions, descriptions and evaluations of the various kinds and categories of P supplements used for poultry and livestock feeding.—*M. J. Blish.* (Biological Abstracts)

GENERAL

HANAHAN, DONALD J., MILDRED BECKER TURNER, and MICHAEL E. JAYKO. (U. Washington, Seattle.)
THE ISOLATION OF EGG PHOSPHATIDYL CHOLINE BY AN ADSORPTION COLUMN TECHNIQUE. *Jour. Biol. Chem. 192:* 623-628. 1951.—An adsorption column technic, in which Al_2O_3 is used, is described for the isolation of phosphatidyl choline from mixed egg phospholipids. All the N was present as choline and the P as glycero-phosphate. The fatty acid to P ratios were from 1.95 to 2.00; neutral and saponification equivalents, from 283 to 298; and iodine numbers, from 78 to 91. No significant change was detected in the ratio of saturated fatty acid in the phospholipid obtained from the column as compared to the starting material. In addition, no free fatty acids or any hydrolytic cleavage products were found in any of the alcohol-soluble fractions.—*R. E. Greenfield.* (Biological Abstracts)

Note:

The Experiment Station Record, published by the Office of Experiment Stations, United States Department of Agriculture, was discontinued as a publication several years ago. References to "Experiment Station Record" in some of the items of this abstract material, therefore, refer not to the publication of this name but to the records kept by the Office of Experiment Stations.

ADDITIONS TO MEMBERSHIP LIST OF THE WORLD'S POULTRY SCIENCE ASSOCIATION

(Received since last issue)

PATRON

IRAQ

Government of Iraq, Darwish Al-Haidari, Director General of Agriculture, Baghdad.

AFFILIATIONS

HOLLAND

C. V. Trouw & Co., 1 Spinozastraat, Amsterdam C.

SWEDEN

Svenska Agghandelsforbundet, Forening u.p.a., Kungsgaten 67A, Stockholm.

SWITZERLAND

Adroka Limited, Nauenstrasse 63, Basle.

MEMBERS

AUSTRALIA

I. R. McCann, Crowlands Road, Stawell, Victoria.

CANADA

W. W. Brown, Saskatchewan Poultry Board, Sask. Co-op. Creamery Bldg., Regina, Sask.
J. H. Strain, Box 18, Lawson, Saskatchewan.
Ed Wise, Poultry Manager, Eaglecrest Farm, Qualicum Beach, B.C.

ENGLAND

D. G. Cowling, 283 Kirkgate Market, Leeds 2.
T. J. Crocker, Min. of Agr., 1/4, Cambridge Terrace, Regent's Park, London, N.W. 1.
G. W. Morley, Lower Nill Farm, Hook Norton, Banbury, Oxfordshire.
G. R. H. Nugent, Blacknest Poultry Farm, Dunsfold, near Godalming, Surrey.
A. E. Spink, Prospect Farm, Easingwold, Yorks.

GERMANY

Rolf Boelts, Entenfarm, Post Edewecht i.O., Westerscheps (Oldenburg).
Andreas Sabarth, Dassendorf bei Hamburg-Bergedorf, Geflugelhof Stein.

ITALY

Hector De Smaele, Casciago-Morosolo, Prov. Varese.

PUERTO RICO

Antonio Budet Dominguez, Mayaguez #37, Hato Rey.

SOUTH AFRICA

T. A. de Beer, Coll. of Agric., Glen, Orange Free State.
J. J. Blignaut, % The High Veld's Regional Office, P/B, Potchefstroom, Transvaal.
J.D.W.A. Coles, Div. of Vet. Serv., Onderstepoort, Pretoria.
H. P. Eloff, Div. of Soil Cons. and Ext., P.O. Box 345, Pietermaritzburg, Natal.
B. H. Field, Dalroyd Poultry Farm, P.O. Seven Oaks, Natal.
L. W. C. Gaymans, 90, Linbro Park, P.O. Edenvale, Transvaal.
W. J. Ham, Box 170, Boksburg, Transvaal.
E. J. Haskell, 1, Winkley Street, Berea, East London, Cape Province.
Mrs. B. van Heerden, P.O. Box 529, Benoni, Transvaal.
W. W. Johnson, Rockdale, Kei Road, Cape Province.
A. H. Jones, P/B 8, Kroonstad, Orange Free State.
T. Moseley, Holmfirth, Arundel Road, Rondebosch, Cape Province.
F. E. O'Grady, P.O. Box 466, Johannesburg.
P. H. C. du Plessis, Oribi Camp, Post Office, Pietermaritzburg, Natal.
L. Saunders, "Glen Berwyn", P.O. Twyfelspoort, Transvaal.
P. J. Serfontein, 7, Noordbrug Road, Potchefstroom, Transvaal.
W. C. J. Viljoen, College of Agriculture, Glen, Orange Free State.
J. P. H. Wessels, College of Agriculture, Cedara, Natal.
H. E. Wicks, P.O. Box 709, Port Shepstone, Natal.
W. N. Young, Cooloch Poultry Farm, Lismore Avenue, Retreat, Cape Province.

IN SECURING POULTRY DISEASE INSURANCE

WISHING WON'T DO . . .
VINELAND VACCINES WILL!

● Among poultry scientists, poultry raisers, hatcherymen, feedmen, wherever poultry products are used, the supremacy of VINELAND VACCINES as matchless insurance against poultry diseases is universally recognized. Gaining this consumer acceptance is the result of rigid scientific effort and farm-tested proof that where flocks have been immunized against specific diseases with VINELAND VACCINES, positive protection was invariably secured.

Yes, a chain of victories has been forged by VINELAND POULTRY LABORATORIES in its endless research and unrelenting battles against the ravages of Newcastle . . . Tracheitis . . . Fowl Pox . . . Pullorum and numerous other poultry profit destroyers. In the wake of each VINELAND conquest, thousands of poultrymen have been able to secure freedom from the risk of mortality.

VINELAND POULTRY LABORATORIES manufacture a complete line of poultry biologics, including Vineland Stained Antigens—K Formula, also K Polyvalent, Sulfaquinoxaline Mixes, Drugs and Disinfectants.

FREE Handbook on Poultry Disease Control with special attention to the prevention of Newcastle Disease, Tracheitis, Fowl Pox and Pullorum. Write today for your copy.

VINELAND POULTRY LABORATORIES

BOX 70 **VINELAND, N. J.**

SWEDEN

I. Dawidson, Malma Stensvag 2, Uppsala 10.
G. Goude, Aggcentralen, Vaxio.
Harald Fors & Co., A.B., Box 471, Stockholm 1.
G. A. Henriksson, Styrsvik, Runmaro.
Curt Holmer, Grangarde Honseri, Box 407, Tungelsta.
John Jacobsson, Skogsholmen, Malmo 15.
Nils G. Jonsson, Hammenhogs, Kontrollhonseri, Hammenhog.
Birger Lindblad, Kragga Gard, Kragga.
Stig Line, Lovasen, Skived.
Nils Persson, Ronneberga 2, Tagarp.
Karl Roslund, Box 9, Strandbaden.

SWITZERLAND

K. Hofer, Geflugelfarm, Egnach (Thurgau).
A. Leutenegger, Geflugelfarm, Hobelwerkstrasse 11, Ober-Winterthur.
P. H. Lutz, Geflugelhof Wattenbuhl, Oberrieden, Zurich.
R. Stahel, Geflugelzucht, Nieder-Uster (Zurich).
Wolff's Geflugelhof, Volketswil-Zurich.

THAILAND

Udom Kiewkingkeao, Poultry Promotion Assn., Phya Thai Rd., Bangkok.
Nai Charoen Uneklabh, % B. Grimm & Company, P.O. Box 66, Bangkok.

AGRICULTURAL COMPANY OF PAN AMERICA

GUILFORD, CONN., U.S.A.

World Shippers of Hatching Eggs, Chicks, Breeding Stock and Poultry Equipment of all kinds.

SHIPMENTS TO 45 COUNTRIES LAST YEAR

WE HANDLE

U.S. Pullorum Clean chicks, turkey poults, chicken, turkey and duck hatching eggs

Feeds

Vaccines

Poultry and Dairy Equipment

We Ship only the best U.S. products from leading breeders and manufacturers.
We Provide the most efficient service possible
We Give personal attention to each order
We Make it easy for world customers to buy in the United States
We Ship by air or ocean to any country in the world.

YOUR INQUIRIES ARE INVITED.

AGRICULTURAL COMPANY OF PAN AMERICA

GUILFORD, CONN., U.S.A.

UNITED STATES OF AMERICA

H. J. Almquist, The Grange Company, Modesto, California.
D. E. Fogg, Merck & Co., Inc., Rahway, New Jersey.
L. M. Morris, Box 1104, Kansas City, Mo.
H. S. Tamimie, 205 Peters Hall, University of Minnesota, St. Paul, Minnesota.

VENEZUELA

Max. Alvarez-laviada, Canonigos a San Ramon, 39-1, Edificio "San Remo," Apto. 20, Caracas.

DR. FRONDA ON LEAVE IN THAILAND

Dr. F. M. Fronda, head of the Poultry Department of the University of the Philippines is on one year's leave of absence in Thailand, promoting the interests of the poultry industry of that country. This arrangement was made possible by the Expanded Technical Assistant Program administered by the FAO in the United States. Dr. Fronda's present address is College of Agriculture, Kasetsart University, Bangkhen, Bangkok, Thailand.—Morley A. Jull.

EXTRA VALUES!

that speed growth and promote health found only in

AUROFAC*

Vitamin B_{12}-Antibiotic (Aureomycin) Feed Supplement

Feed manufacturers who have incorporated AUROFAC in their feeds or feed supplements know that this Lederle product contains two of the more important factors in the field of animal nutrition: aureomycin and vitamin B_{12}.

These two factors, however, are not entirely responsible for the exceptional growth response of chickens and turkeys to feeds containing AUROFAC.

There are *other* factors. Additional nutritional contributions are supplied by unidentified factors in aureomycin fermentation products.

Repeatedly, nutritionists in Agricultural Experiment Stations have found that AUROFAC in the ration consistently does a better job of promoting growth and health than an equivalent amount of crystalline aureomycin and vitamin B_{12}.

Poultry feeds containing AUROFAC have shown outstanding results. Birds grow faster, are more healthy, and reach market weight, or come to full meated maturity, sooner. There are fewer culls and less mortality, higher egg production and greater hatchability in breeder stocks.

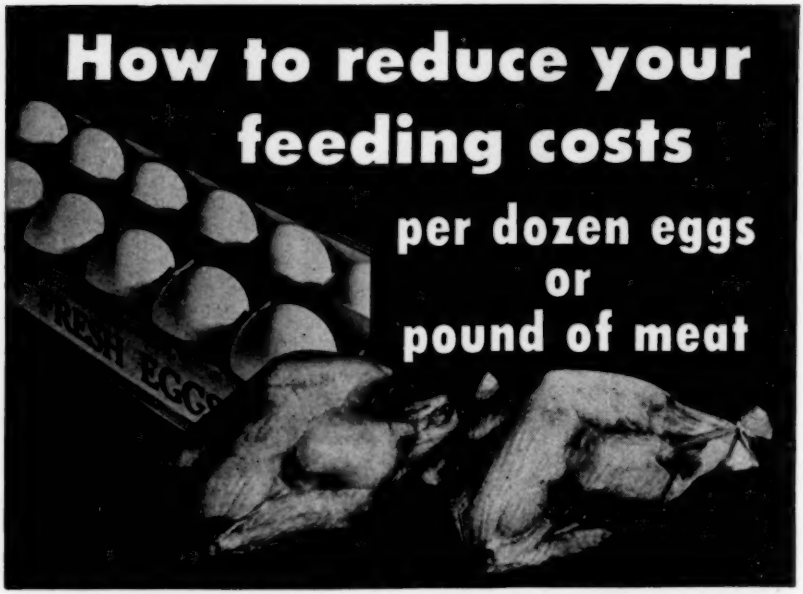
AUROFAC improves the *best* rations even when they contain adequate amounts of vitamins, meat and fish. Write us at the address below for full information on AUROFAC.

*Trade-mark

Animal Feed Department

LEDERLE LABORATORIES DIVISION

30 Rockefeller Plaza AMERICAN Cyanamid COMPANY New York 20, N. Y.



STONEMO'S EXTRA GRINDING SURFACES

help your feeds do more work at less cost!

Tests show that hens average 7% more eggs with 6.3% less feed—broilers show a feed efficiency *increase* up to 5 pounds of meat per 100 pounds of feed—when insoluble grit is included in their feed programs.

Poultrymen everywhere are profiting handsomely from such results. That's why they insist upon STONEMO insoluble grit as part of all their feeding programs to *grind out more eggs or meat from every pound of feed.*

STONEMO's *extra grinding surfaces* grind out more value from the nutrients in the birds' feed—help make these nutrients more usable for better egg production and faster growth. STONEMO saves costly feed—gives you bigger profits at market time.

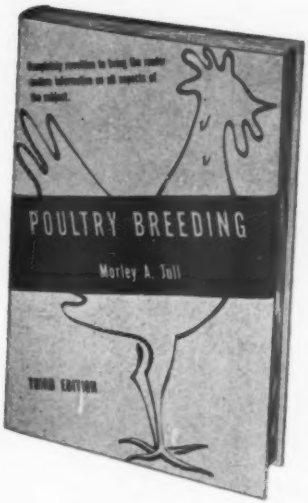
Insist upon STONEMO, the hard insoluble grit, to grind out bigger profits for you. Ask for STONEMO at your local feed or poultry supply dealer. Remember STONEMO's cost is small—its savings large.

STONE MOUNTAIN GRIT COMPANY

***Executive Offices & Quarry,* LITHONIA, GEORGIA**

***Branch Quarry,* BARRE, VT.**

Important new books in poultry science



JULL'S "classic" revised

POULTRY BREEDING

By Morley A. Jull,
University of Maryland

THIRD EDITION — COMPLETELY REVISED & REWRITTEN With Aids to Selection, Efficiency of Various Mating Systems and Breeding Methods, Viability and other New Techniques For Improving Poultry Quality.

Complete and latest fundamental data on poultry husbandry and its practical economic problems.

CONTENTS: Breeds and Varieties of Chickens. Physiology of Reproduction. Mechanism of Inheritance. Color Characters. Morphological Characters. Gene Linkage and Blood Group Antigens. Fertility and Hatchability. Viability. Meat Production. Egg Production. Egg Characters. Selection Methods (by C. S. Shaffner).

1952 398 pages, 132 illustrations $6.00

BOTSFORD writes guide to cut financial risk

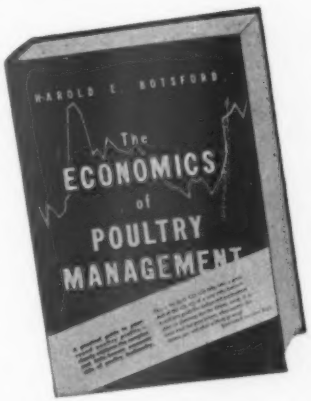
THE ECONOMICS OF POULTRY MANAGEMENT

By Harold E. Botsford, *Cornell University*

Clearly explains basic factors in planning and producing consistently better-than-average profits.

From planning to profitable balance, this up-to-date book is packed with facts and figures on all phases of modern poultry husbandry.

CONTENTS: Commercial Development of Poultry Industry in U.S. Financial Opportunities in Poultry Husbandry. Benefits and Limitations. Prices, Receipts, Purchasing Power of Eggs. Market Egg Production. Season of Hatching. Systems of Flock Replacement. Chick Industry. Hatching-Egg Production. Chick Production. Pullet Production. Size of Business. Rate of Production. Light vs. Heavy Breeds. Labor Efficiency. Capital. Business Factors. Reorganizing a Farm for Poultry. Broiler Industry. Turkey, Duck, Squab, Goose, Guinea Industries. Farm Costs and Prices in Marketing Poultry and Eggs.



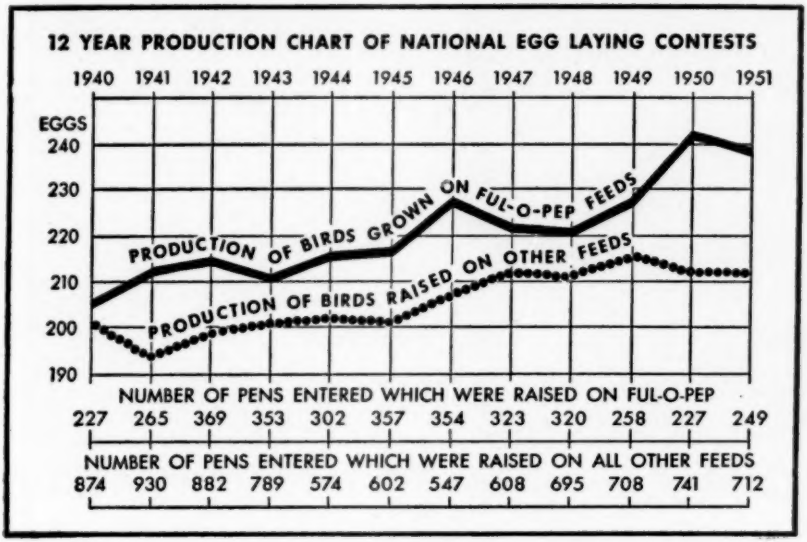
1952 337 pages, illustrated $5.75

Write to day for copies on approval

JOHN WILEY & SONS, INC.

Dept. WP-52, 440 Fourth Avenue, New York 16, N. Y.

National Egg Laying Contests prove FUL-O-PEP GROWS AMERICA'S BEST PULLETS!


12 YEAR PRODUCTION CHART OF NATIONAL EGG LAYING CONTESTS
1940 1941 1942 1943 1944 1945 1946 1947 1948 1949 1950 1951
EGGS
240
230
220
210
200
190
PRODUCTION OF BIRDS GROWN ON FUL-O-PEP FEEDS
PRODUCTION OF BIRDS RAISED ON OTHER FEEDS
NUMBER OF PENS ENTERED WHICH WERE RAISED ON FUL-O-PEP
227 265 369 353 302 357 354 323 320 258 227 249
NUMBER OF PENS ENTERED WHICH WERE RAISED ON ALL OTHER FEEDS
874 930 882 789 574 602 547 608 695 708 741 712

Birds grown on Ful-O-Pep average laying the equivalent of 15 MORE 2-OZ. EGGS EACH

INFORMATION PRESENTED in the above chart is excellent proof that Ful-O-Pep grows America's Best Pullets.

YOU WILL NOTE that for the past 12 years in these official contests 46,852 Ful-O-Pep raised birds averaged laying the equivalent of 15 more 2-oz. eggs each than the average of 112,606 birds grown on all other feeds. And during this time over half of the winning pens and hens were grown on Ful-O-Pep.

IN THE 1951 CONTESTS Ful-O-Pep raised birds averaged laying the equivalent of 24 more 2-oz. eggs each than birds grown on all other brands of feed. Ful-O-Pep feeders also won high pen in 8 and high hen in 7 of the 15 official tests.

CERTAINLY THIS SUPERIOR egg production is outstanding proof that Ful-O-Pep Research is building better feeds. Best of all, the Ful-O-Pep Restricted Feeding Plan saves poultrymen up to 30% feed cost for growing pullets . . . the kind of birds that produce well and stand up under the strain of heavy, continuous laying.

THE QUAKER OATS COMPANY

. . . makers of dependable feeds for over 60 years

"BASIC PRODUCERS" *of* NUTRITIONAL PRODUCTS *from the* SEA . . . .

"Basic Producers" of vitamin concentrates — not just blenders or mixers — that's the important thing to remember about Whitmoyer Laboratories, Inc.

Extensive, modern Whitmoyer marine products processing plants strategically located along the Atlantic Coast—in New England and in Nova Scotia—produce thousands of tons of meals and oils. From these basic raw materials—rich in natural vitamins and valuable marine proteins—are developed, through our own nutritional experiments and practical farm use, products which are scientifically sound and economically practical.

WHITCOD, our pure cod liver oil, fortified to any required potency, has long been recognized for its uniformly high quality and reliability.

*CLO-MEAL and FLAV-A-DEE, dry vitamin concentrates made from a cod liver meal base, have been used with outstanding results in hatchability and production.

TRA-MIN, the original patented trace mineral compound with its famous stabilized marine "protein-bound" iodine content has proven to be the ideal way to incorporate the essential trace elements with a single product.

For more complete information on these and other Whitmoyer products—including the Whitmoyer line of Poultry and Livestock Health Products—write us today.

*CLO-MEAL and FLAV-A-DEE, as well as other Whitmoyer vitamin concentrates, are natural sources of Vitamin B_{12}. When these products are used at our recommended levels, supplemental amounts of B_{12} are not required.

Whitmoyer LABORATORIES INC

Manufacturing Chemists

MYERSTOWN, PENNA., U.S.A.

Branch Plant
ROCKLAND, MAINE

In Canada
YARMOUTH, N.S.
WHITMOYER LABORATORIES, LTD.,